THE ELECTRICAL REVIEW

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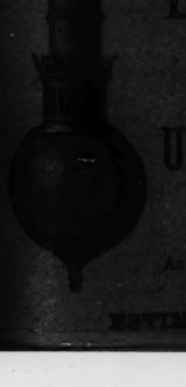

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ELECTRICITY AND RAILWAY WORKING.

THE exigencies of railway traffic are such that of necessity electricity has become an active agent in its management. It is, however, questionable, freely as it is employed, whether railways afford many opportunities for the advancement of electricity in its application to railway working. A block or telegraph system once established upon a line of railway is difficult to replace, or even to modify. The staff become acquainted with its mode of operation, and the regulations under which it is worked. In a large number of instances the knowledge for working the instruments has been acquired by those who have now the handling of them, in recent years, and when the individuals themselves had arrived at years of maturity. To look for such an one to readily forget that which at so much labour he has acquired, and as readily accept that which is novel would be to look for an impossibility; and this is well known by our railway men. Hence, then, it happens, that as a rule whatever system is adopted by a railway to that system the railway company becomes wedded. However great may be an improvement, and however desirable its adoption may appear, should its adoption involve the introduction of something new in the manipulation, or of a new code of instructions, so great would the difficulties attending such a change prove, that practically they would become insurmountable. With regard to apparatus of a less general or universal character changes do take place and improvements are effected, but these are not changes of a very radical character, and do not affect the principle upon which the company bases or works its system, and which forms the staple part of its electrical apparatus. To this in its general principle it is wedded, and hence, as we observe, it is questionable if railway companies do afford a brilliant field for electrical advancement.

This in a great measure will explain why, when we glance back over the past 10 years, so little that is new appears to have taken root upon our railway systems. Those which have adopted the block—and we are happy to note that there are very few which have not—continue to use it as of yore with but little if any modification or improvement. Extended it they undoubtedly have; whilst all new lines have now, under Board of Trade regulations, to be provided with it e're they are passed for opening. True, this all means an extension of the system. It means manufacture and business, but it hardly means improvement.

But is improvement ready at hand? The recognised block systems have proved themselves useful. Railway traffic, where it has been worked under properly considered instructions, has been worked well and with but few failures, and where failure has stepped in it has very seldom been shown to be the result of the instrument. What need, then, of any improvement?

To this we reply that improvement is at hand. Good and capable as may be the means adopted for the regulation of railway traffic, those means do not go so far as they might, or as is desirable; they do not afford the fullest possible protection. It is a well known fact, and one to which attention has more than once been directed, that the action of the electrical block apparatus is independent of that by which the movement of the trains is governed. Electrical apparatus is employed to signal trains from point to point, whilst for intimating to the driver of a train whether he is to go on or to stop, mechanical apparatus, entirely dissociated from the electrical apparatus, is made use of. It is true the signalman knows that his mechanical signals have to be worked in accordance with his electrical signals, and great is the credit due to those by whom the signals have to be operated for the good and faithful manner in which the duty as a rule is performed. But where the action of the one set of apparatus is so interwoven with that of another, none can doubt the desirability of so combining them that the one cannot be worked without the sanction of the other; in fact, that the two should interlock.

The proposal is by no means new, and inventors and manufacturers have in no way treated the subject with indifference. There is at the present moment more than one system by which that which is desired may be accomplished without, we believe, in any way interfering with the existing form of instrument employed or with the manner of working it. We hope shortly to go further into this subject, and to lay before our readers details of those systems which have been brought into practical use, however small that may be.

Having in view the desirability of such a combination one is naturally tempted to inquire how it occurs that its adoption has not become more general. The question is a difficult one to answer. We do not believe there are fifty miles of line so provided, yet systems such as we have referred to have been in operation for some time and with success. Its adoption has from time to time been recommended by the Board of Trade, but in no single instance has the suggestion, we believe, been accepted, save in that of the Canonbury accident. Doubtless the introduction of the automatic brake, and the more general use of the interlocking frame for working the mechanical signals and points, has tended largely towards the reduction of accidents; and this in a measure is possibly one reason for deferring the additional cost which must necessarily accompany the establishment of such an auxiliary. Still, inasmuch as a combination of the electrical with the mechanical signals must add to the general security of working, its accomplishment is desirable, and we venture to hope that the date is not far distant when we may see further advances in this direction.

Another advance to which we look forward is that of the illumination of our railway carriages. The present means of lighting railway carriages is notably deficient, and although efforts are being made in this respect to more adequately meet the wishes of the great body of the travelling public by most of the larger and more important companies, it is questionable if satisfaction will be assured without the aid of electricity. In the employment of the electric light for this purpose railway companies have at their disposal a means fully adequate to the end in view, and although its introduction may for a time be attended with some inconvenience, we feel that the companies possess men capable of meeting and overcoming whatever difficulty may arise in its application. Doubtless it is a question which will require some consideration, for railway companies will not be anxious to involve themselves in difficulties similar to those which attended the introduction of the automatic brake. The matter is now quite capable of being thrashed out, and it is one which we very earnestly commend for consideration. Certain it is that that railway company which affords a good and readable light will secure the best traffic.

We would not, in thus referring to two of the most important branches in which electricity may with advantage be employed, have it thought that we are unmindful of the many other channels in which its adaptability has commended it for use. Nor would we have it thought that improvements and advances have not been made in its application in these smaller channels. These improvements we are at all times pleased to chronicle, and shall not fail, as opportunity from time to time arises, to do so.

PRACTICAL NOTES CONCERNING THE CONSTRUCTION, USE AND MANAGEMENT OF STORAGE BATTERIES.

By A. RECKENZAUN.

THERE are at the present moment indications which tend to give one the idea that the manufacture of storage batteries is fast devoloping into a great industry, and if the existing rate of advance is maintained, we may expect that this new industry will soon become one of national importance. England is now the only country in which secondary batteries are produced on a sound commercial basis, and the progress which has been made is in a great measure due to large pecuniary sacrifices during the early stages of development. By small and apparently insignificant steps, and with great efforts and much unnecessary labour, have these batteries been brought to a certain state of perfection, and there can be no doubt that further improvements will yet be brought about; but such improvements will be sought in the direction of increased durability and reduction in cost of manufacture.

The premature confidence reposed in secondary batteries was long ago destroyed by early failures. Successes during the last two years, however, have had the effect of partially re-establishing confidence, and we may regard it as a happy incident that a reaction did not set in suddenly, for in that case there would have been a rush for the article, and in the attempt to satisfy too great a demand, without the requisite means of supply, inferior articles would probably have found a market.

How far the storage battery has re-established itself in public favour may be gathered from the fact that some £60,000 worth of storage batteries have been legitimately ordered and sold during the past twelve months. This represents in the aggregate about 1,000 tons of cells; this amount has been furnished by two or three firms in this country; we take no account of the tons of storage batteries which have not an established reputation, but which may have found purchasers, and others that may still pine in "purgatory."

The importance and desirability of an economical and practical secondary battery has been fully recognised by all who have considered the subject, and it is generally accepted that though there is a considerable amount of loss in the conversion of energy, the undeniable convenience of a method of electrical storage greatly compensates for the attendant waste. Besides the loss of energy there are two other objections to the employment of storage batteries, and these are first cost and depreciation. How far these objections may be justified, how far they have been removed, and in what direction they may be still further eliminated, will be the theme of these notes.

Loss of Energy.—It was generally assumed, in times when dynamo machines gave an efficiency of only 70 per cent., that the losses between the shaft of the prime mover and the terminals of the battery amounted to about 50 per cent. of the available power; modern dynamos, however, have an efficiency of 85, and some even 90 per cent. But in the application of the accumulator as an auxiliary to an installation, we have neither to blame nor to credit the cells with the goodness or the defects of the dynamo; and makers of dynamos would at once inform us that the secondary battery has to stand on its own merits. The efficiency, therefore, of the storage apparatus is a fraction of the total energy supplied to it by the electric generator, and this fraction amounts to not less than $\frac{7}{10}$ or 70 per cent.; in other words, for every 100 watts sent through the cells, 70 watts at least reappear as useful work.

Let us express this loss in terms of pence or a fraction thereof, assuming the source of energy to be coal at 20s. a ton converted into mechanical energy through a steam boiler and engine, consuming fuel at the rate of 5 lbs. per horse-power per hour. In round numbers, the cost of coal will come to one halfpenny, and since the steam horse-power has been found to yield sufficient energy through the medium of a dynamo to keep eight lamps of 20 candle-power incandescent, the light per lamp hour, as far as coal is concerned, will cost one-sixteenth of a penny.

Through the intervention of the storage battery then the cost per lamp per hour, in fuel, is raised to nearly one-eleventh of a penny. There is, of course, also more water used, and a greater wear and tear of machinery if the plant is working 10 hours for charging, and the accumulators alone are to supply light during seven hours without the engine. It is, however, seldom arranged that the engine is to stand idle whilst the maximum number of lights is required, and when the charging machinery is working in conjunction with the accumulator, the latter serving principally as a regulator or safeguard, then only part of the current generated by the dynamo would pass into the cells and the loss will be less in proportion. Against the objection relating to waste of energy, we may yet place the fact, that, when only a few lamps, out of many, are required to be alight, as would frequently be the case in most installations, we need not work the engine and dynamo, the wear and tear of which, as well as cost of attendance, is practically the same whether five lamps are in use or as many hundred. Moreover, if the consumption of fuel constituted the major part of the cost of electric lighting, then with the above figures before us we may still stay to consider whether it would be wise to adopt the storage system, but we know that the cost of coal in large installations is less, and in medium sized and small installations much less than one-half of the total outlay, hence the apparently big waste of 30 per cent. of the available power will appear small in comparison with the sum of items involved in electric lighting, when on an average we may take the value of a lamp hour at one half-penny, or between five and six times the cost of the fuel at the comparatively extravagant rate of 5 lbs. per horse-power hour and 20s. the ton.

The foregoing is merely an example of a case where steam power has to be expressly put down for the purpose of electric lighting, but there are numerous instances when the advantages of storage batteries outweigh the evil of waste entirely, where they come in not only as a great convenience but with absolute economy, always providing that their prime cost and maintenance are within reasonable bounds, which must and will be the case so long as the price of lead does not much exceed present rates and improvements in manufacturing processes continue to be effected. These favourable cases we may now proceed to consider.

First.—A case where the available source of power is small but continuous. There are thousands of factories, works, or mills using steam power throughout the day, and where a small increase of horse-power above the ordinary requirements will hardly be appreciated, and where the hours of darkness even in winter do not exceed three or four per day. There a dynamo may run off the common shafting all day with hardly any attention, and accumulate quietly in secondary batteries the energy requisite for lighting the shops in the evening or early in the morning. Again, there may be a small steam engine, gas engine, or a small water wheel or turbine running continuously for 12 or even more hours a day, the power of which might be inadequate to give light to a given number of lamps by direct application, but energy might be accumulated during the many hours when not otherwise wanted; this would virtually amount to double or treble the power of the source for the few hours when used for lighting or other purposes.

Secondly.—A case, local circumstances being favourable, of even greater importance than the first, where power from a natural source would be entirely running to waste, where in consequence we should have a decided gain even were the efficiency of the apparatus not more than 20 or 30 per cent. instead of actually 70 per cent. This is the case with rapidly flowing rivers and waterfalls in the vicinity of towns, industrial centres, or residences. In the United States some 14,000 H.P. are taken from waterfalls which formerly ran to waste but now furnish the best of all illuminations, and on the Continent of Europe also water power is similarly largely applied, but in none of these advantageous situations are as yet storage batteries used, although they might treble the capacity of the plant. This is principally because the improved batteries are not sufficiently known, and partly because they are still looked upon as being too expensive.

Thirdly.—A case where the stored energy is to be utilised when away and disconnected from the generator. Electric cars and electric boats illustrate this case.

These are old stories dished up afresh; when first told, five years ago, they were mere theories, exercises of enthusiasm: to-day they are realisations. To-day by this repetition we record facts. This makes all the difference.

(*To be continued.*)

ACCOMPLISHED AT LAST!

TRULY, the world knows nothing of its greatest men—until, if they happen to be inventors, they have properly "secured their foreign patents!"

Our readers will find at another page of this paper a description of a dynamo invented by Mr. Ernest P. Clark, for which we are indebted to our American contemporary, the *Electrical World.* Mr. Clark, with that charming disregard of history which is one of the characteristics of all really great men, announces that he has—we have his advertisement to prove the fact—at last accomplished the utilisation of the interior of the Gramme ring, by grooving the pole pieces at one side and causing the armature to rotate in the grooves. There is no doubt something to be said in favour of this form. There is also, with still less doubt, something to be said against it, especially in the arrangement of the Clark dynamo. But whatever is to be said in favour of it is due to the numerous inventors—most prominent amongst whom are Jürgensen, of Copenhagen, and Fein, of Berlin—who have worked at the idea in years gone by. We do not propose to criticise the construction. It is not really very bad, after all, although it might be better without the magnets between which the commutator is placed. We leave it to be admired by those of our readers who don't know much about dynamos, and proceed to examine the testimonial to its excellencies written by Mr. P. H. Van der Weyde, President of the New York Electrical Society.

Very few men can write an out-an-out testimonial. Mr. Van der Weyde is one of those men. His remarks on the Clark dynamo are worthy of their subject. The first part of this document draws attention to the fact that Mr. Clark has nearly doubled the efficiency of the Gramme ring—which, as it was about 80 per cent. before, is therefore now nearly 160 per cent.—and has produced a machine of a most handsome and well-proportioned design. Mr. Van der Weyde then goes on to say:—"In regard to the effectiveness, I will only state that with a driving power of ten horses" it gives 9 ampères and 759 volts. This is not impossible. It is only 91·5 per cent., a return we are quite used to, even in this "played-out" old country. But, according to Mr. Van der Weyde, this is 70 per cent. more than is ordinarily obtained, for "a 100 horse-power dynamo as now in use will light 100 lamps; a 100 horse-power dynamo of the Clark type will light 170 lamps, a gain of seventy lamps over every hundred, attained by the addition of the interior magnetic field." From this unanswerable argument we can, if fond of figures, readily ascertain that the efficiency of dynamos "as now in use" is 53·5 per cent. It was, indeed, time that Mr. Clark took the matter up. The illustration of the armature of the Clark machine shows that it has a core, presumably of iron wire or rings of sheet iron, wound with the conductor in the ordinary Gramme fashion. This is a good form; but, as far as we know, is not new. Why, then, are we told that "the judicious distribution of the coils in this machine has resulted in the absence of heating effects produced by the generation of the Foucault currents?" This passage contains much food for thought, and shows how little really is known about dynamos by Messrs Clark and Van der Weyde.

THE BELL TELEPHONE PATENT PROBABLY BROKEN.

THE claims of the Bell patent as at present construed by the courts cover the art of transmitting speech electrically. In the face of the famous Morse decision, says the *Scientific American*, a construction of claim fully as broad as that refused to Morse has been contended for and obtained by the Bell advocates. It is construed to cover the transmission of speech by the "undulatory current." By this current the diaphragm of a receiving instrument is assumed to be kept under permanent control of the diaphragm of a transmitter. It is all theory, but as accepted by the courts as a standard for judging of mechanical constructions, has a most important bearing on the extent of protection afforded by the Bell patents. It makes this protection absolute for all and every imaginable electric telephone.

The scope conceded to this claim is quite incompatible with the state of the art as illustrated by the Reis device alone. If anyone had affirmed a few years ago that from the records of the American Patent Office a complete anticipation of this broadly interpreted patent of Bell would be exhumed, none would have credited the assertion. Yet this has now been done. A telephone far superior to Bell's crude and inoperative device of 1876, or the somewhat better one of 1877, is illustrated in our columns elsewhere. It is an exact reproduction of a device patented by the early telegraphic inventor, Royal E. House, in 1868. His name is one of the best known in connection with the early history of the art. He was the first inventor of a printing telegraph. He stands side by side with

Prof. Morse and Prof. Bain in the history of electric progress. To-day, nearly 80 years old, he still lives, connecting the past with the present.

Royal House, in 1865, patented what he termed an improvement in electro-phonetic telegraphs. No relay was used in this system; by increasing its sensibility, he hoped to avoid the necessity for one. In this way Morse's claims would not be infringed. Not satisfied with his progress, a second improvement under the same title was patented three years later, and the new device was a telephone.

This 1868 patent describes a perfect telephone, designed to work as a telegraph receiver. The loud and very disagreeable clicking that a telephone under certain circumstances produces is familiar to all. It works as a sort of magnifier of sound. To make the sound produced by the make and break of a weak current acting on an armature more audible, Royal House availed himself of this telephonic principle. He invented a sounder that could work with very weak currents, because it was a telephone. It possessed a diaphragm and tube adapted for listener or speaker, just as the Bell telephones in his patents of both 1876 and 1877 did. The instrument may be adjusted so that changes in current will produce blows upon the diaphragm, or by adjusting screws the production of blows may be prevented and changed into that of impulses only. When this change is made, the apparatus for production and use of the "undulatory current" appears. According to the description of the House patent, a minute change in the adjusting screws will effect this. He contemplates a motion of the armature of only one hundredth of an inch. An adjustment to this extent by screws shown in the patent drawings is therefore enough to prevent the hammering.

That this species of adjustment came within the literal scope of the patent is not only evident from the presence of the adjusting screws, but is proved by the following very remarkable clause in the specification:—"I have found, by experiments, that when the force of an armature of a receiving magnet is expended on limiters, F^1, F^2, by limiting the motion of the armature a distinct, audible sound is produced, even when the electrical power is only sufficient to produce motion."

The inventor, in other words, had tried the effects of reducing the play of the armature, and there is no doubt that eight years before the invention of Bell Royal E. House had heard the impulses of a telegraphic current audibly reproduced telephonically by the "undulatory current." The inventor, it is true, did not realise the full powers of his invention. Two of these instruments, actuated by a battery or by their residual magnetism, will operate as well, or better, than a pair of the modern Bell telephones. Prof. House did not specially claim or describe them as speaking instruments in his patent. Neither did Bell do so in his 1876 patent with reference to his instruments. But a device is protected by letters patent for all possible uses, and some very curious results may yet follow if suits are brought against the Bell Company under this patent.

An interesting confirmation of our views so frequently expressed as to the Bell claim is afforded by this patent. It overshadows, in importance, the Reis inventions, as it is so much their superior in efficiency. Neither is it a crude and impracticable telephone, like the earlier Bell devices. On the contrary, by legitimate inventive work, Royal E. House, the contemporary of Morse, constructed a telephone as good as the instrument in use at the present day.

One fortunate circumstance in connection with this instrument, as concerns its use in litigation, is that all the facts can be so concisely proved. The patent, in a clear drawing and description, shows what the instrument is. A simple inspection shows that it is a telephone. By connecting two of them in a circuit they will talk, thus practically showing that they are telephones. The date of the invention is far enough back to remove all danger of claims of priority of invention on Bell's part. The bearing of this invention on the extravagant claims of the telephone monopoly would seem very evident. If it can ever be brought before the courts, it will be an entirely new matter and will justify a new decision by a circuit judge. At present these judges are governed by decisions already rendered. But this new matter in the shape of a prior patent, the most convincing of all proof, must certainly force a new decision that will limit the Bell claims. An attempt is now to be made to bring it before the circuit court on a final hearing.

Interesting in the abstract as this case may be as a feature in the history of the invention of the telephone, it assumes great importance in view of the aspect that the Bell controversy has recently acquired. Charges affecting the integrity of the methods of the Patent Office have been recently made an issue in Government proceedings against the Bell patents. It is alleged that the Bell patents were fraudulently granted, that Bell was given access to Gray's caveat, and that corruption marked the whole of the proceedings in the matter of his 1876 patent. So serious were these allegations that the Government suit mentioned above was instituted solely on their account, and is now in progress to determine their truth or falsity. The confirmation afforded them by this discovery falls little short of absolute proof. The examiner must have known of the House patents. Their inventor's name was famous. The subjects of the Bell and House patents were similar or almost identical. The drawings resemble each other closely. Interpreted by the specification, Bell's device is anticipated by a vastly superior apparatus. It is unfortunately a matter hardly susceptible of doubt that the contents of the House patent were known to the authorities when the Bell patent was granted. For the general public this patent will seal the condemnation of the Patent Office proceedings. The matter should have a great effect on the Government suit.

Meanwhile, some of the old cases are beginning to appear in the Supreme Court of the United States. On the first of the present month motion was made in that court to advance and hear together, immediately after the February recess, all the telephone suits on the docket. Twenty-five thousand printed octavo pages are in the records of these suits. The argument on the united cases is expected to occupy a week. They include the Dolbear, the Molecular, the Clay Commercial, the People's (or Drawbaugh), and the Overland suits.

Progress in these suits will be watched by all with much interest. Unfortunately, none of the cases represents the full proofs, as they are all burdened with concessions, or characterised by omissions of some parts of the facts in the case. More results may reasonably be looked for from the House telephone than from the Supreme Court.

THE CLARK DYNAMO.

THIS machine is the invention of Mr. E. P. Clark, of Oswego, N.Y.

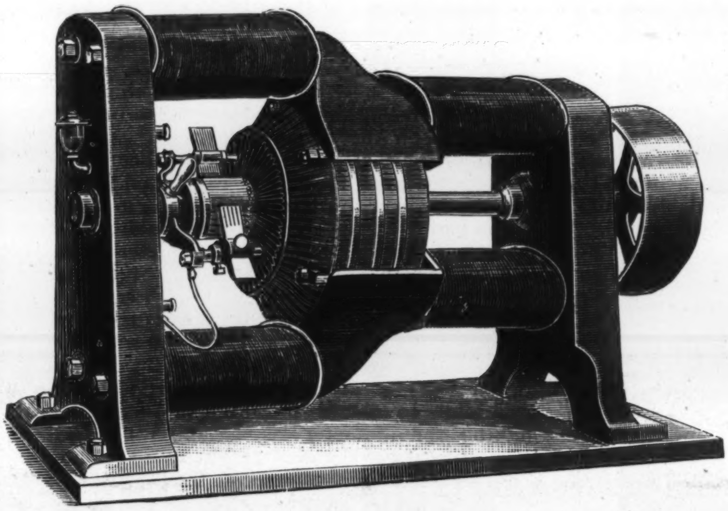
In the usual form of Gramme machine, as is well known, the portion of the wire on the armature on the inside of the ring is not under the direct influence of the magnetic field, and it was with the object of overcoming this defect that Mr. Clark designed the improvements in the machine illustrated in the accompanying engravings. The complete dynamo is shown in perspective, and the other figure shows the construction of the field magnets.

As will be noted, the field magnets are of the consequent pole type, and so arranged that while the inner pole-pieces are specially magnetised by the short field magnets, the outer pole-pieces are magnetised by the long magnets. Mr. Clark has found, however, that with this construction alone the inner pole-pieces are not so strongly magnetised as the outer ones, and to prevent inequality of action he has added two auxiliary magnets, which connect the inner pole-pieces and are energised by the same current as the others. In this way a uniform action is obtained.

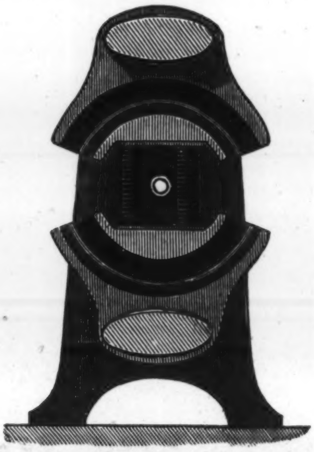
The armature has a spider at one end of the ring, so that the coils fit into the grooves in the pole-pieces, as will be readily understood.

Tests have recently been made of the machine, which was belted to a dynamometer and run at 850 revolutions per minute. After some time, readings were taken from the dynamometer, ammeter, and voltmeter, and they were as subjoined :—

Current (C)	9 amps.
Potential at terminals	759 volts.
Power applied (W)	7,871 watts.
Friction of machine running idle (F)	307 watts.
Internal resistance of machine ...	6·1 ohms.
External resistance (r)	84·3 ohms.
Total resistance (R)	90·4 ohms.
External electric energy $C^2 r$ ...	6,828 watts.
Total electric energy $C^2 R$	7,322·4 watts.
Efficiency of conversion $\frac{C^2 R}{W - F}$ ...	96·81 per cent.
Commercial efficiency $\frac{C^2 r}{W}$	86·74 per cent.



THE CLARK DYNAMO.



FIELD MAGNETS OF CLARK DYNAMO.

The machine as exhibited at the American Institute is well finished throughout.

PRACTICAL DEDUCTIONS FROM THE FRANKLIN INSTITUTE TESTS OF DYNAMOS.

THE tests of dynamo-electric machines, made in 1885 under the auspices of the Franklin Institute, are undoubtedly the most reliable and complete of all the impartial tests which have ever been made and published, and they therefore afford the practical electrical engineer an excellent opportunity to deduce proportions, dimensions and constants, to assist him in designing dynamos, especially as the machines which were tested are among the best that are made, and represent the results of tedious and expensive experimenting on the part of the makers, while, at the same time, they embody the improvements suggested by long and continued use of the machines in practice.

Dynamos have frequently been built by "guessing" at the proportions, constructing them, and then trying them to "see what they will give." If they then turn out (by chance) to give the electromotive force and current desired, the designer generally gets the credit for having made very correct "calculations"; while if they give, for some unknown reason, quite different results, the manufacturer has to be consoled with the statement that "it is not possible to calculate the parts of a dynamo."

If a machine is at hand which can be thoroughly tested and measured in all its parts, it is not difficult for a technical engineer, who is well informed concerning the principles and practice of dynamo building, to calculate the parts of another machine of the same type which will give a certain desired electromotive force and current slightly different from that of the first machine. But when the designer has no access to such a model machine, or if the current and potential desired differ greatly from those of the model, it is difficult, if not quite impossible, to calculate with any degree of certainty the parts of a dynamo from the principles and laws of induction and resistance, without some practical constants and proportions, which can be obtained only from existing machines.

As an aid and guide in such calculations, a set of practical constants and proportions have been calculated by the writer (Mr. Carl Hering in the N.Y. *Electrical Engineer*) from the valuable tests of the Franklin Institute. These constants will not only materially diminish the amount of "guessing" in designing machines, but it is believed they are sufficiently complete to enable a technical engineer to calculate all the electrical proportions of a well designed cylindrical armature which is to give a certain required electromotive force and current. It is to be regretted that the data given in the Franklin Institute Report are not sufficient to enable a similar complete set of constants to be deduced for the field. A few of these may, however, be calculated, and they will materially aid in determining certain parts of the field. The calculations of armatures being based on induction and conductivity, the constants from one armature may be used in calculating others ; but in the field this is not the case, as the relation between the exciting current and the magnetism produced depends very largely on the size, shape and proportions, of the coils and the iron parts, including the cores, the so-called neutral parts, pole pieces, &c., as well as on the quality of the iron. As these are so very different in different machines, the constants obtained from one would be of little use in determining the size of other fields, except, perhaps, the constants given below for the intensity and amount of the magnetism of the field. A careful and systematic builder of dynamos will in most cases run the armature, when completed, with its own field-magnet frame with temporary, removable coils of known number of turns, on the magnets, in order to find, by regulating the current in these temporary field coils, how many ampère-turns are required in the field to induce the desired electromotive force and current in the armature. From this number of ampère-turns any competent dynamo builder can readily calculate the proper windings of the magnets with all due accuracy.

Numerous theories of dynamo-electric machines have been advanced, but most of them are of greater interest to the mathematician and the physicist than to the practical dynamo builder. More attention seems to have been given to integrals, complicated abstruse fractions and formulæ for determining the presumably correct values for extreme impossible cases, than to simple, practical formulæ, by means of which tangible results may be obtained for the ordinary forms of machines. In some cases, formulæ based on physical theories have been suggested, which might have been of practical use if accompanied by the absolute and reliable values of certain constants usually represented by Greek letters, which enter as direct factors in the formulæ; but the values of these constants have either been omitted, or else have been given within such wide ranges that they cannot be used to any advantage in practice. They are sometimes of such a nature that they differ for each machine, thus necessitating the construction and testing of the machine before the values of the constants for calculating this particular machine may be determined; which is, to say the least, a very awkward way of applying a formula.

The writer has, therefore, set aside all abstruse theories of the dynamo, which have yet to stand the severe test of varied practical application, and has endeavoured to deduce from the results given in the Franklin Institute Report some constants, or values, which are in such a form that they may be directly applied to the calculations of the armature and some parts of the field. The deductions of these constants are based only on the well-known laws of induction and of mechanics, and as they are calculated from actual cases, they show what *is* done in practice, as distinguished from what *might be* done according to some theory, provided the theory is correct.

The results tabulated on the following page not only give the values which can be used in designing machines, but an attempt has also been made to determine the efficiency of separate parts; thus indicating under what circumstances the most advantageous proportions may be arrived at. Some proportions used in calculating the numbers given in the table were not contained in the report, and, therefore, had to be estimated, except where they were furnished to the writer by the kindness of the manufacturers. But the errors which may have been introduced by a slightly inaccurate estimate, are so small that they do not materially affect the results. Certain slight errors, or modifications, in some of the figures, or proportions, were not taken into account, as they cannot be determined; but they are of such a nature as to affect equally, or approximately so, all machines not differing too widely from the style of those tested. Among these is the self-induction of the armature; in well built machines, like those tested in which the field is intense, the speed not too high, the number of commutator bars or coils large, and the number of windings per coil very small, the self-induction will be very small, and, therefore, the difference between the self-induction in these different armatures may be neglected.

In the table given below, the deduced constants have been accompanied by many of the proportions from which they were derived, as copied from the report, in order to show some of the principal proportions of the machines, and to give the conditions under which the constants have the values given. Numerous other values in the report might have been repeated here, but as it is presumed that any one can obtain the original report, they are omitted. The values chosen for the deductions were taken from that one of the full load tests in which the current and potential were nearest to the values given by the makers as the best working load.

The following assumptions were made, as the accurate data for deducing the same were wanting. The speed in the Edison No. 4 machine was not given in the report; that given here is the speed at which the makers say the machine is to be run, and it is assumed that the speed must have been very nearly this in the test. The percentage of the whole circumference of the armature which is embraced by the pole pieces was, in the Weston machines, assumed to be about 80 per cent., as this was the proportion in some arc light machines of the same makers, which we understand have the same type of frame. The distance between the pole piece projections was determined from this in the Weston machines. In the Edison machines the length of the pole pieces and the armature core, were deduced from the statement in the report giving the length of useful wire in a coil; it was assumed that by the term "useful wire," was meant that which lies directly between the pole pieces and the armature core. In the Edison machines it was assumed that the length of the armature core was the same as that of the pole pieces; in the Weston machines this was the case.

As the electromotive force induced in an armature is dependent upon the amount of magnetism passed through per second, the first questions in designing armatures are: How great may the velocity of the moving wire be? What must its length be? What must the intensity of the field be? &c.

The first of these, the velocity of the moving wire—commonly called the "conductor or inductor velocity"—depends on the distance of the active wire from the centre of the shaft, and on the number of revolutions of the armature. It may be calculated from the speed and the mean of the external diameter and the diameter of the core. In the accompanying table, the horizontal column, *a*, contains the external diameters, *b* the internal, and *c* the mean. From this mean value the circumference in feet was calculated, which, when multiplied by the speeds *d*, and reduced to seconds, gives the inductor velocities in feet per second, in column *e*. From these values it is seen that the Edison armatures have a higher velocity of the moving wire; also, that it is preferable to obtain the high inductor velocity by making the diameter as great as practical, rather than to increase the number of revolutions, as will be seen by comparing the small, high-speed armature of the Edison No. 4 with the large one of the Nos. 10 and 20.

To obtain a constant by means of which the length of wire may be calculated, the total electromotive force in volts which was generated, has been divided by the length of that part of the wire in which it is generated. This wire will be termed the "active wire" and, in these deductions, has been limited to that portion of the armature wire which lies directly between the pole pieces and the armature core. Strictly speaking this is not quite correct, as some induction does undoubtedly take place in some parts of the wire lying at the ends of the armature, and also in some of the longitudinal wires which are not directly between the armature core and the pole pieces; but the induction in both of these parts is presumably so small as compared with that in other parts, that it may be neglected, especially as the constants are to be applied to similar armatures, thus eliminating this error. The length of the active wires were calculated from the following proportions. Column *f* gives the number of coils or commutator bars; *g* the number of turns per coil, and *h* the resulting total number of turns on the armature. The proportion of these coils which are active, is calculated from the distance between the pole-piece projections, column *i*, and the circumference determined from the diameters in column *a*; the ratio of this is given in column *j*, in percentage of the circumference of the armature which is active; this will also represent the percentage of the number of windings which are active. Column *k* gives the length of a pole piece in inches, which is the same as the length of the armature core. From these the total length of the active wire in feet can be calculated, remembering that every turn of wire on the armature represents twice the length of the pole piece; but as the two halves of the armature wires are in multiple arc only half of this induces the whole electromotive force. The total electromotive force in volts, given in column *l*, is then divided by this half length of active wire in feet, giving the induction in volts per foot in column *m*. As this induction is slightly different in different positions of the wire with reference to the pole pieces, these results give the mean value. They show that the induction is considerably higher in the Edison than in the Weston machines; also, that it is very nearly the same in all the Edison, and nearly the same in the three Weston machines.

	Reference letter.	Edison No. 4.	Edison No. 5 or T.	Edison No. 10 or S.	Edison No. 20 or H.	Weston 6 M.	Weston 6 W I.	Weston 7 M.
External diameter of armature in inches ...	*a*	7·063	7·875	10·625	10·625	8·031	8·250	9·375
Internal diameter or diameter of the core ...	*b*	6·250	7·063	9·688	9·688	7·387	7·410	8·595
Mean diameter in inches	*c*	6·657	7·469	10·156	10·156	7·709	7·830	8·985
Speed in revolutions per minute	*d*	1600	1400·8	1208·6	1092·1	1114·9	1257·6	1043·5
Mean inductor velocity in feet per second ...	*e*	46·5	45·6	53·6	48·2	37·4	43·0	41·0
Number of coils or commutator bars	*f*	50	50	64	44	72	56	64
Number of turns per coil	*g*	2	2	1	1	2	2	2
Total number of turns on armature	*h*	100	100	64	44	144	112	128
Mean distance between pole piece projections in inches	*i*	2·69	2·313	3·50	4·88	2·52	2 58	2·94
Active part of circumference of armature in per cent. (approx.)	*j*	76	80	80	71	80	80	80
Length of pole piece or armat. core in inches	*k*	12	13	16·5	29·5	14	14	16·5
Total E.M.F. in volts	*l*	131·91	131·5	129·35	129·60	127·17	136·22	165·58
Mean induction in volts per foot	*m*	1·733	1·515	1·838	1·687	·948	1·304	1·175
Volts per foot for 1 foot per second	*n*	·0373	·0332	·0343	·0350	·0254	·0303	·0287
Mean intensity of field in lines of force per square inch	*o*	25,900	23,000	23,800	24,260	17,630	21,000	19,900
Amount of magnetism in field in lines of force	*p*	2,660,000	3,090,000	5,250,000	8,600,000	2,490,000	3,042,000	3,860,000
Energy in field in horse-power	*q*	·394	·401	·675	·862	·207	·402	·498
Useful lines of force per volt-ampère in field (relative efficiency of field)	*r*	90·2	103·1	104·1	133·5	161·1	101·5	103·7
Length of wire in one coil in inches	*s*	92	102	68	98	154	151	160
Total length of armature wire in feet (parallel wires considered as one)	*t*	383	425	363	359	924	705	853
Available active length in feet	*u*	152·0	173·4	140·8	153·6	268·8	209·0	281·6
Percentage of same, which is active	*v*	40	41	39	43	29	30	33
Diameter of naked armature wire in inches ...	*w*	·148	·180	·199	·199	·141	·190	·175
Number of wires in parallel	*x*	1	1	2	3	1	1	1
Total current in armature	*y*	84·42	103·31	205·50	392·42	72·84	100·60	128·16
Square mils of cross-section per ampère ...	*z*	407	492	606	475	428	562	374
Percentage of energy in armature	A	3·70	4·65	3·12	3·39	5·43	3·09	5·59
Total electrical energy in horse-power ...	B	14·93	18·23	35·67	68·25	12·43	18·39	28·47
Relative efficiency of armature as an inductor	C	11·33	8·44	7·90	10·17	4·32	4·62	6·94
Useful commercial efficiency of machine ...	D	88·38	89·76	89·70	91·90	87·38	90·21	89·92
Depth of winding in inches	E	·407	·406	·469	·469	·322	·420	390
Percentage of diameter taken up by windings	F	11·5	10·3	8·83	8·83	8·02	10·2	8·32
Distance between pole piece projections divided by depth of windings and clearance ...	G	5·0	4·4	5·9	8·2	5·65	4·75	5·72
Ratio of length to diameter of armature core	H	1·9	1·8	1·7	3·0	1·9	1·9	1·9
Ratio of length to diameter of bearings ...	I	4·2	4·3	4·1	4·1	4·2 & 3·6	4·2 & 3·6	3·8 & 4·3
Volts per commutator bar	J	6·7	6·25	4·9	7·2	4·2	5·9	6·1

These constants are dependent on the velocity of the inductor, for it is evident that if the latter were higher the induction would be increased. In order, therefore, to properly compare these constants, it is necessary to eliminate the velocity by dividing these figures by the velocities in column *e*, thus giving the volts per foot which would be induced (in the respective fields) at a uniform velocity of one foot per second. This is given in column *n*, and shows the number of volts induced per foot for an inductor velocity of one foot per second. These may be compared with each other as the velocities are the same. They show that at the same velocity the induction is better in the Edison than in the Weston machines; also that the values agree very closely for all the Edison, except for the No. 4 machine, which may possibly be attributed to the number assumed for the speed, which was not taken in the test. For the Weston 6 M it is lowest, which is, no doubt, due to a less-intense field.

The next question which naturally arises is, what was the intensity of the field in these machines? This may be determined as follows: We know that a volt is 100,000,000 times the unit of electromotive force in the absolute system, and also that one absolute unit of electromotive force is generated when a wire cuts lines of force at the rate of one per second; therefore one volt is induced if a wire cuts 100,000,000 lines of force per second. As we know the number of volts in one foot (column *m*) in these machines, and also the number of feet moved through in one second (column *e*), we can readily calculate the intensity which the field must have had to induce that number of volts in one foot. To illustrate this, suppose the velocity was one foot per second, and that the induction was one volt per foot at this velocity, then it is evident that the surface moved over by one foot of wire in one second, that is, one sqnare foot, must contain 100,000,000 lines of force; or, if the induction was two volts per foot, there must be 200,000,000 lines of force in this space, as this number must have been cut per second to generate two volts. Dividing this number by 144, will give the mean intensity of the field in number of lines of force per square inch. These figures are given in column *o*. They show that with one exception, all the Edison machines have very nearly the same intensity of field; also, that it is somewhat lower in the Weston, especially in the 6 M machine; but, as will be seen, it is more economically obtained in this one, which indicates that it was probably not over saturated.

These values might also have been obtained by multiplying those in column *n* by 100,000,000 and dividing by 144, which is equivalent to multiplying them by 694,444. This will be seen by considering the principles of the deductions.

The total useful amount of magnetism in the whole field is evidently the intensity per square inch multiplied by the size of the field in square inches. As the intensity has been calculated from the amount of induction, the amount of magnetism thus obtained does not include the leakage of the magnetism, that is, those lines of force which are not cut by the armature wire, it therefore represents the useful magnetism only. The same lines of force which enter the armature at one pole piece pass through it to the other pole piece, and therefore the total number of lines of force is the intensity multiplied by the curved area of one pole piece. These figures are given in column *p*, and are deduced from columns *o*, *a*, *j* and *k*. The magnetism increases with the number of volt-ampères which the machine generates.

This amount of magnetism is generated at the expense of a certain quantity of electrical energy in the field magnets. In order to get some approximate values for calculating roughly how much electrical energy will be required for generating, in practice, a certain amount of magnetism in similar fields, the figures in column *p* may be divided by the amount of energy in volt-ampères, which was required in these cases to generate the respective fields. In the report the figures in column *q* are given, which are the energy in horse-power consumed in the fields. Unfortunately the resistance of the field without the regulator box was measured only in one machine, so that the energy given here represents more than that used in the field magnets themselves, thus introducing an error in all the deductions made from these values. It is presumed, however, that at full load the resistance in the box was not large, so that the error will probably be small. Reducing this energy in the field to volt-ampères and dividing it into the amount of magnetism, gives the number of useful lines of force generated per volt-ampère in the field. These are given in column *r*. As they depend on so many different proportions of the parts of the field and magnet coils, and also in a measure on the armature, they might vary considerably for different types of field-magnets, and can, therefore, be used only in making rough preliminary calculations. They agree tolerably well for these fields, except for the Weston 6 M, which is evidently better proportioned than the others. As these figures are the ratio of that which is produced to that which is required to produce it, they may be said to represent the *relative* efficiencies of the different fields, in which sense they represent no absolute efficiencies, but serve simply to compare the efficiencies with one another. In the Edison machines we believe wrought iron alone is used, while in the Weston both wrought and cast iron were formerly used together, and we presume were used in these machines also. Possibly the iron in the field of the Weston 6 M machine is not over saturated, which may be the reason of its high efficiency of field.

The wires of the armature being wound repeatedly around it, pass through the same field a number of times, thus utilising the same field in one revolution for successive inductions in the same wire. This number of turns, as given in column *h*, multiplied by column *j*, may therefore be said to represent the economic use of the field; it does not follow, however, that the best armature is the one having the greatest number of turns on it, as it is quite the reverse, other more important considerations, such as self-induction, sparking, &c., requiring that the number of turns of wire be as small as practicable.

In deducing the number of volts per foot, only the active wire was taken into consideration. In designing armatures it is therefore necessary to know what the proportion is between the active and the total length of the wire, for if the active length is determined first from the number of volts to be generated and the induction per foot, we must find what the total length is in order to determine the resistance or cross-section of the wire. This proportion of active to total length will evidently depend on several dimensions of an armature, and will, therefore, vary somewhat in different machines. For these machines it was determined as follows: column *s* contains the mean length of wire in one turn (where several smaller wires are in parallel they were considered as one); this multiplied by the number of coils in column *f*, gives the total lengths in column *t*; these divided into the active length in column *u*, give the percentages in column *v*. From the latter it will be seen that the economy of the wire is considerably better in the Edison than in the Weston, and that it is best in the Edison No. 20, the proportion between the length and diameter of the armature being greatest in this one. Most of the proportions from which these percentages have been deduced were given by the makers.

The density of the current in the armature wire can be determined from the diameters of the wire in column *w*, the number of wires in parallel in a coil in column *x*, and the total current in the armature in column *y*. Dividing the latter into the double area of cross-section of the wire in square mils, or the double sum of the cross-sections of the parallel wires, gives the number of square mils per ampère in column *z*. These numbers vary somewhat with the current and with several other proportions; they should, therefore, be used only as a general guide, or for making preliminary calculations. The best method for determining the cross-section, is to find the resistance from the amount of energy which is allowed to be lost in the armature, which together with the total length of the wire as determined from the induction per foot, &c., gives the required cross-section.

The percentage of energy in the armature as taken from the report, is given in column A. Those in which the loss is least, Weston 6 WI and Edison No. 10, have the greatest area of cross-section of wire per ampère (column *z*), while the one in which the loss is greatest, Weston 7 M, has the least cross-section per ampère. This relation does not necessarily exist between them all, as the percentage of loss depends also on the induction per foot of wire, and therefore on the length of the wire.

The relative efficiencies of these armatures, as inductors, may be seen from the figures in column C. The efficiency as an inductor, apart from that as a converter of energy, is greater the larger the total amount of electrical energy induced (column B), and the less the amount of wire necessary to effect this induction; it may, therefore, be expressed by the quotient of the two. The figures in column C have, therefore, been calculated by dividing those in column B by the lengths in column *t* and by the double area of cross-section determined from columns *w* and *x*, the decimal point being changed to reduce them to a convenient form. By themselves these figures represent nothing, but by comparing them with one another they show which of the armatures are the best proportioned as inductors. They show that the Edison are considerably better proportioned than the Weston. The most efficient armature is, strange to say, the smallest one, Edison No. 4, which is no doubt due to its having the most intense field (column *o*), the highest speed (column *d*), and almost the smallest cross-section of wire per ampère (column *z*); this higher efficiency is, however, obtained at the expense of the efficiency of the field, as will be seen from column *r*; the useful commercial efficiency of the whole machine is, therefore, below the average, as seen from column D. Next to this armature, in point of efficiency as an inductor, is the largest one, Edison No. 20; its high efficiency is no doubt due to the great intensity of field (column *o*), the very small amount of wire on the armature (column *t*), the relatively high inductor velocity (column *e*), the large proportion of active wire (column *v*), and the comparatively small cross-section of the wire, per ampère (column *z*). The field of this machine has next to the highest efficiency as seen in column *r*, and therefore, as might be inferred, the machine has the best useful commercial efficiency of all of those tested, as seen in column D. It may be interesting to mention here that in this machine which has the best efficiency, the armature wires cut the field less frequently than in any other, as seen from the number of turns in column *h*.

Another proportion which may serve as a guide in designing armatures, is the relation between the outside diameter of the armature and the diameter of the core, or what amounts to the same thing, the percentage of the external diameter which is taken up by the wire on both sides. These figures are given in column F, and are obtained by dividing twice the depth of the windings given in column E by the external diameter in column *a*. This is greatest in the smallest armature, Edison No. 4, showing another disadvantage of small armatures; it is least and therefore best, in the Weston 6 M, which may partially account for the economic field shown in column *r*, as the latter depends on this non-magnetic space.

A few other proportions may be deduced from the data given. One of these is the proportion of the distance between the pole piece projections and the double distance, between the pole pieces and the armature core. This proportion should evidently be as great as practicable. The figures are given in column G and are obtained from columns *i* and E, allowing about $\frac{1}{16}$th of an inch for clearance on each side. It is greatest for the largest machine, Edison No. 20, which may partially account for its economic field in column *r*. The reciprocals of the figures in column G may be said to represent approximately the intensity of the leakage of magnetism, as compared to the intensity of the useful field at these places, as the lines of force have the choice of these two paths. But this will be only a rough approximation as a field is always more intense at points or sharp edges.

Another useful proportion is the relation between the length and diameter of the armature core, as deduced from columns *k* and *b*. It is given in column H, which shows by comparison with column *v* the advantage of a long armature. The Weston machines appear to be quite uniform in this respect, the length being almost twice the diameter.

Column I gives the relation between the length and diameter of the bearings.

Column J gives the electromotive force between two neighbouring commutator bars. If this is great enough to maintain an arc across the insulation of the commutator bars (about 20 volts) there is danger of starting the well-known flash, encircling the whole commutator, if the brushes should be misplaced sufficiently far to start the arc. It will be seen to be far within the limit of 20 volts in all of these machines.

The Edison Nos. 10 and 20 machines afford a good opportunity to compare two armatures of different lengths, but having all the other sizes and proportions alike, including the number of windings, size of wire, depth of winding, &c., only that in the one three wires are connected in parallel, and in the other, two; and that in the No. 20 the distance between the pole-piece projections is greater, making a difference of about 10 per cent. in the number of active wires in favour of the smaller one. The chief gain of the long armature is seen in column *v*, in which it has the highest percentage, which partially accounts for the efficiency in column C, and the consequent commercial efficiency in column D.

The subject of self induction of the armature was purposely omitted here, partly because insufficient data are given in the report to make any practical deductions regarding it, but principally because it is presumed that the self-induction in such armatures as these, with very few turns, is so small that it may be neglected in such rough values as have been deduced here. It is to be regretted that the resistance of the field coils without the regulator box was not measured in each case in order that the effect of the self-induction of the field coils in increasing the apparent resistance could be calculated, and its relation to the number of pulsations or commutator segments determined. In only one case was the field resistance measured alone, and from this a calculation shows an increase of resistance of less than one-tenth of 1 per cent., and, therefore, probably less than the allowable error in measurement.

The fact that the Edison Nos. 5 and 20 machines gave way in the armature insulation, will not lessen the value of these deductions to the designer of dynamos, as this was presumably a defect in the details of construction and not in the proportion of parts.

The test of the 20-light machines were marked unofficial in the report because the preliminary run of 10 hours was not on full load; but they are no doubt sufficiently accurate for the deductions of the approximate values in the table.

The deductions made here are not for the purpose of comparing the commercial value of these machines, as it has been shown in the tests that they are practically equal electrically. The most important consideration in this respect would be the cost of the machines and the cost of maintenance and attendance, which cannot be considered here.

For the benefit of any one not familiar with these machines, it may be added that they are all simple shunt machines, with cylinder armatures.

In conclusion, it may be said that the values deduced in the table may not be free from small errors, as great accuracy was not possible in all cases, owing to the want of some few detail dimensions; moreover, great accuracy has no particular value in such general deductions as these.

DYNAMO-ELECTRIC MACHINERY.*

By J. HOPKINSON, M.A., D.Sc., F.R.S., and E. HOPKINSON, M.A., D.Sc.

(*Concluded from page* 491.)

In order to ascertain the friction of bending the belt round the pulley, B, and of the journals of the dynamo, a preliminary experiment was made with the dynamometer. The combination was run at a speed of 814 revolutions per minute with the dynamos on open circuit and the tension of the spring observed—9,979 grammes.

TABLE I.

	I. Revolutions per minute.	II. Grammes.	III. Watts.	IV. Volts.	V. Ampères.	VI. Ohms.	VII. Watts.	VIII. Watts.	IX. Watts.	X. Watts.	XI. Watts.	XII. Watts.	XIII. Watts.	XIV. Watts.
1	810	8,392	3324	129·1	21·6	1·39	13	4	984	861	110	4,720	676	5,396
2	801	9,299	3642	127·2	72·0	1·39	75	62	955	770	130	10,678	825	11,503
3	811	11,113	4413	125·8	150·0	2·72	267	223	935	825	294	21,014	935	21,949
4	808	10,433	4116	124·4	186·0	2·72	394	344	914	695	387	25,256	691	25,947
5	792	10,660	4124	116·5	211·0	2·72	501	445	801	608	454	26,592	657	27,249
6	798	16,897	6595	110·6	351·0	4·59	1317	1231	722	581	1099	41,567	822	42,389
7	764	17,690	6604	110·12	358·0	4·09	1360	1274	716	472	1117	42,086	831	42,917
8	766	17,804	6669	110·6	360·0	4·59	1335	1296	722	452	1151	42,451	856	43,307
9	778	16,556	6300	102·3	369·0	4·09	1443	1361	618	396	1176	40,304	653	40,957
10	756	20,412	7537	96·8	446·0	4·59	2070	1978	554	348	1668	46,242	459	46,701
11	808	9,526	4758	119·3	36 8	2·72	394	344	855	636	211	7,011	1009	8,020
12	802	...	1512	113·5	No current	...	...	...	...	...	...	...	756	...
13	814	3,175	1262	...	...	...	...	...	...	...	...	...	631	...

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* From the Philosophical Transactions of the Royal Society.

The engine was then reversed, and the dynamos run at the same speed and the tension of the spring again observed—3,629 grammes. The difference of the two readings gives twice the power absorbed in friction, viz.: 1,262 watts for the two machines, or 631 watts per machine. This is excluded entirely from the subsequent determinations of efficiency, as being a quantity dependent on such arbitrary conditions as the lubrication of the journals, the weight of the belt, and the angle it makes with the horizontal.

In Table I. column I. is the speed of the dynamos; column II. is the reading of the spring in grammes; column III. is the power transmitted by the belt in watts; column IV. is the potential at the terminals of the generator; column V. is the current passing in the external circuit between the two machines; column VI. is the resistance introduced into the magnets of the motor by the rheostat; column VII. is the power absorbed in the armature of the generator; column VIII. is the power absorbed in the armature of the motor; column IX. is the power absorbed in the magnets of the generator; column X. is the power absorbed in the magnets of the motor; column XI. is the power absorbed in the connecting leads between the two dynamos, in the rheostat resistance *r*, and in the standard resistance used for measuring the current; column XII. is the total electrical power developed in the generator; column XIII. is half the power absorbed by the combination less the known losses in the armatures, magnets, and external connections of the two machines; column XIV. is the total mechanical power given to the generator, being the sum of the powers given in columns XII. and XIII.

TABLE II.

	I. Per cent.	II. Per cent.	III. Per cent.	IV. Per cent.	V. Per cent.	VI. Per cent.
1	0·25	18·23	12·52	69·0	71·44	40·44
2	0·65	8·30	7·17	83·88	69·9	58·63
3	1·235	4·27	4·27	90·22	89·68	79·9
4	1·52	3·53	2·66	92·29	92·78	85·63
5	1·84	2·94	2·415	92·81	93·70	86·51
6	3·11	1·70	1·94	93·25	93·79	87·45
7	3·17	1·66	1·94	93·23	93·37	87·05
8	3·08	1·67	1·98	93·27	93·99	87·26
9	3·525	1·51	1·59	93·37	94·02	87·49
10	4·47	1·20	1·00	93·39	93·62	87·43
11	0·31	3·53	2·66	92·29	92·78	85·63

In Table II. the percentage losses in the armature and magnets of the generator are given, as also the sum of all other losses as obtained from column XIII. in the foregoing table; also the percentage efficiency of the generator, of the motor, and of the double conversion. Column I. is the percentage loss in the generator armature; column II. is the percentage loss in the generator magnets; column III. is the percentage sum of all other losses in the generator; column IV. is the percentage efficiency of the generator; column V. is the percentage efficiency of the motor; column VI. is the percentage efficiency of the double conversion.

In this series of experiments in all cases, from Nos. 1 to 10 inclusive, the brushes, both of the generator and motor, were set at the non-sparking point; but in No. 11 no lead was given to the brushes of the generator, and, consequently, there was violent sparking throughout the duration of the experiment.

In No. 12 the magnets were separately excited with a current giving 113·5 volts across their terminals. The power absorbed must be due entirely to local currents in the core of the armature, and the energy for the reversal of magnetisation of the core twice in every revolution of the armature.

No. 13 gives the results of the experiments on the friction of the bearings and in bending the belt already referred to.

It will be observed that the figures in column XIII. are calculated by deducting the power absorbed in the armatures and magnets, and extraneous resistances from the total power given to the combination as measured by the dynamometer. They must therefore include all the energy dissipated in the core of the armature, whether in local currents or in the reversal of its magnetisation; also the energy dissipated in local currents in the pole-pieces, if such exist; also the energy spent in reversing the direction of the current in each convolution of the armature as they are successively short circuited by the brushes. Further, it will include the waste in all the connections of the machine from the commutator to its terminals and the friction of the brushes against the commutator. A separate experiment was made to determine the amount of this last constituent, but it was found to be too small to be capable of direct measurement by the dynamometer. Moreover, from the manner in which the figures in this column are deduced, any error in the dynamometric measurement will appear wholly in them. Since, undoubtedly, the first two components enumerated are the most important, and the conditions determining their amount are practically the same throughout the series, the close agreement of the figures in the column are a fair criterion of the accuracy of the observations. Probably 100 watts is the limit of error in any of the measurements. Such an error would affect the determination of the efficiency when the machines were working up to their full power to less than ¼ per cent.

It has been assumed that the sum of these losses is equally divided between the two machines. This will not accurately represent the facts, as the intensities of the fields and the currents passing through the armatures differ to some extent in the two machines. The inequality, however, cannot amount to a great quantity, and if it diminishes the efficiency of the generator it will increase the efficiency of the motor by a like amount, and contrariwise. In No. 11 of the series the effect of the sparking at the brushes of the generator is very marked, the power wasted amounting to at least 250 watts.

If it be assumed that the dissipation of energy is the same whether the magnetisation of the core is reversed by diminishing and increasing the intensity of magnetisation without altering its direction, or whether it is reversed by turning round its direction without reducing its amount to zero, a direct approximation may be made to the value of this component. (J. Hopkinson, Phil. Trans. vol. 176 (1885), p. 455.)

The core has about 16,400 cubic centims. of soft iron plates, hence loss in magnetising and demagnetising when the speed is 800 revolutions per minute $= 16{,}400 \times \frac{800}{60} \times 13{,}356$ ergs per second = 292 watts.

Referring to Table II. it appears that the efficiency approaches a maximum when the current, passing externally between the two machines, is about 400 ampères. Let c be the current in the armature, ρ its resistance, w the power absorbed in all parts of the machine other than the armature, then, if the speed is constant, the efficiency is approximately $\frac{E\,c - w - c^2\,\rho}{E\,c}$, where E is the electromotive force. This is a maximum when $\frac{w}{c} + c\,\rho$ is a minimum, which occurs when $w = c^2\,\rho$; when the loss in the armature is equal to the sum of all other losses. For the machines under consideration the experimental results verify this deduction But in actual practice the rate of generation of heat in the armature conductors, when a current of 400 ampères was passed for a long period, would be so great as to trench upon the margin of safety desirable in such machines. Of the total space, however, available for the disposition of the conductors only about one-fourth part is actually occupied by copper, the remainder being taken up with insulation, and the interstices left by the round wire. If the space occupied by the copper could be increased to three-fourths of the total space available, while the cooling surface remained the same, the current could be increased 75 per cent. and the efficiency increased 1·3 per cent. approximately, as all losses other than that in the armature wires would not be materially altered.

The loss in the magnets is also susceptible of reduction. It has already been shown that for a given configuration of the magnetic circuit and a given electromotive force the section of the wire of the magnet coils is determinate. The length is, however, arbitrary, since within limits the number of ampère convolutions is independent of the length. An increase in the length will cause a proportionate diminution in the power absorbed in the magnet coils. If the surface of the magnets is sufficient to dissipate all the heat generated, then the length of wire is properly determined by Sir William Thomson's rule that the cost of the energy absorbed must be equal to the continuing cost of the conductor.

APPENDIX.

(Added August 17th.)

Since the reading of the present communication experiments have been tried on machines having armatures wound on the plan of Gramme and with differently arranged magnets, the experiments were carried out in a closely similar manner to that already described.

Description of Machines.

It will be observed that the magnetic circuit is divided. The pole-pieces are of cast iron and are placed above and below the armature, and are extended laterally. The magnet cores are of wrought iron of circular section and fit into the extensions of the cast iron pole-pieces, so that the area of contact of the cast iron is greater than the area of section of the magnet. The magnetising coils consist of 2,196 convolutions on each limb of copper wire, No. 17 B.W.G., in No. 1 machine, and 2,232 convolutions in No. 2 machine. The pole-pieces are bored to receive the armature leaving a gap on either side subtending an angle of 41° at the axis.

The bearings are carried upon an extension of the lower pole-piece.

The following table gives the principal dimensions of the magnets in No. 1 machine:—

	cms.
Length of magnet limbs between pole-pieces ...	26·0
Diameter of magnet limb	8·6
Bore of fields	25·7
Width of pole-piece parallel to the shaft ...	24·1
Width of gap between poles	8·6

The armature is built up of plates as in the machine already described, and is carried from the shaft by a brass frame between the arms of which the wires pass.

The principal dimensions are as follows:—

	cms.
Diameter of core	24·1
Diameter of hole through core	14·0
Length of core over end plates	21·1

The core is wound on Gramme's principle with 160 convolutions, each consisting of a single wire, No. 10, B.W.G., the wire lying on the outside of the armature in a single layer. The commutator has 40 bars.

This dynamo is compound-wound, and is intended for a normal output of 105 volts 130 ampères, at a speed of 1,050 revolutions per minute. The resistance of the armature is 0·047 ohm, and of the magnet shunt coils 53·7 ohms.

There is here no yoke, and consequently A_4 and l_4 do not appear in the equation.

It is necessary to bear in mind that the magnetising force is that due to the convolutions on one limb, and that the areas are the sums of the areas of the two limbs. In calculating induction from E.M.F. it is also necessary to remember that two convolutions in a Gramme count as one in a Hefner-Alteneck armature.

A_1.—The section of the core is 245 sq. cms.; allowances for insulation reduce this to 220·5 sq. cms.

l_1.—This is assumed to be 10 cms., but it will be seen that an error in this value has a much more marked effect on the characteristic in this machine than in the other.

A_2.—The angle subtended by the bored face of the pole-pieces is 139°, the mean of the radii of the pole pieces and the core is 12·45 cms. Hence the area of 139° of the cylinder of this radius is 768·3 sq. cms.; add to this a fringe of a width of 0·8 of the distance from core to pole pieces as already found necessary for the other machine, and we have 839·5 sq. cms. as the value of A_2.

l_2 is 0·8 cm.

A_3 is 365 sq. cms. (*i.e.*, the area of two magnet cores).

l_3 is 26·0 cms.

A_5 is taken to be 955 sq. cms., viz., double the smallest section of the pole piece.

l_5 is a very uncertain quantity; it is assumed to be 15 cms.

The expression already used requires slight modification. Inasmuch as the pole pieces are of cast iron a different function must be used. Different constants for waste field must be used for the field, the pole pieces and the magnet core. We write

$$4\pi n c = l_1 f\left(\frac{I}{A_1}\right) + 2\,l_2\,\frac{\nu_2\,I}{A_2} + l_3 f\left(\frac{\nu_3\,I}{A_3}\right) + 2\,l_5 f'\left(\frac{\nu_5\,I}{A_5}\right)$$

the function f' is taken from Hopkinson, *Phil. Trans.*, vol. 176 (1885), p. 455, plate 52. ν_2, ν_3, and ν_5 were determined by experiment as described below, their values are

$$\nu_2 = 1{\cdot}05$$
$$\nu_3 = 1{\cdot}18$$
$$\nu_5 = 1{\cdot}49$$

Comparing the curves* on plate 17 with that on plate 19, the most notable difference is that in the present case the armature core is more intensely magnetised than the magnet cores. No published experiments exist giving the magnetising force required to produce the induction here observed in the armature core, amounting to a maximum of 20,000 per sq. cm. We might, however, make use of such experiments as the present to construct roughly the curve of magnetisation of the material; thus we find that with this particular sample of iron a force of 740 per cm. is required to produce induction 20,000 per sq. cm.: this conclusion must be regarded as liable to considerable uncertainty.

The observations on the two machines are plotted together, but are distinguished from each other as indicated. They are unfortunately less accurate than those of plate 17, and are given merely as illustrating the method of synthesis.

Experiments to determine ν_2, ν_3, and ν_5.

The method was essentially the same as is described on pp. 338 and 339, and was only applied to No. 1 machine. Referring to fig. 7 a wire, A A, was taken four times round the middle of one limb of the maguet, a known current was suddenly passed round the magnets, the elongation of the reflecting galvanometer was observed, it was found to be 214 scale divisions, giving 107 as the induction through the two magnet limbs in terms of an arbitrary unit. The coil was moved to the top of the limb as at B B—the elongation was reduced to 206 or 103 for the two limbs. We take the mean induction in the magnet to be 105. A wire was taken three times round the whole armature in a horizontal plane as at C C; the elongation observed was 222 divisions or 74 in terms of the same units. A wire was taken four times round one-half of the armature as at D D; the elongation was 141, or induction in the iron of the armature 70·5, whence we have

$$\nu_2 = \frac{74}{70{\cdot}5} = 1{\cdot}05.$$

It may be well to recall here that ν_2 is essentially dependent on the intensity of the field, strictly the line B on plate 19 should not be straight but slightly curved.

Four coils were taken round the upper pole piece at E E; the elongation was 159, giving 79·5 on the two sides. Coils at F F give a higher result, 87·5, owing to the lines of induction which pass round by the bearings of the machine, and across to the upper ends of the magnets $-\nu_5$ is taken to be $\frac{83{\cdot}5}{70{\cdot}5} = 1{\cdot}18$.

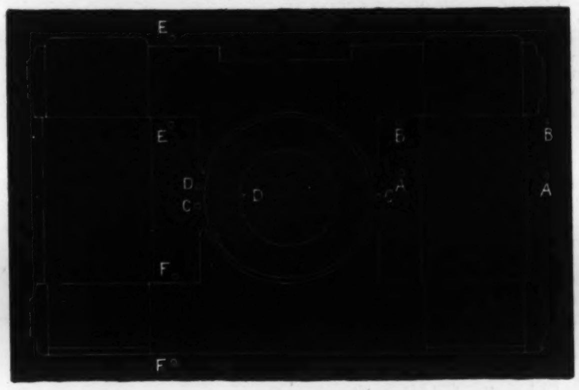

FIG. 7.

Efficiency Experiments.

The method and instruments were those already described, pp. 346 and 347, excepting that the current was measured by a Thomson's graded galvanometer, which had been standardised against a Clark's cell in the position and at the time when used. The resistance of leading wires and galvanometer was 0·034 ohm, the series coils introduced for compounding the machines were also brought into use, and the losses due to their resistance find a place in columns XII. and XIII. of the following Table III., in which column I. is lead of brushes of the dynamo, positive for the generator, negative for the motor; column II., revolutions per minute; column III., deflection of spring in grammes; column IV., watts by dynamometer; column V., volts at terminals of generator; column VI., ampères in external circuit; column VII., rheostat resistance; column VIII., watts in generator armature; column IX., watts in motor armature; column X., watts in generator shunt magnet coils; column XI., watts in motor shunt; column XII., watts in generator series magnet coils; column XIII., watts in motor series; column XIV., watts in external resistances; column XV., total electrical power of generator; column XVI., half the sum of losses unaccounted for; column XVII., total mechanical power applied to generator.

TABLE IV.

	Generator armature.	Generator shunt coils.	Generator series coils.	Other losses.	Efficiency of generator.	Efficiency of motor.	Efficiency of double conversion.
1	5·8	2·2	3·0	1·9	87·1	89·0	77·5
2	2·0	7·5	1·0	5·5	84·0	92·0	77·7

Table IV. gives the losses and efficiencies as percentages in exactly the same way as in Table II., excepting that another column is introduced for the loss in the series coils of the magnets of the generator.

The core of the armature contains about 6500 cub. cms. of iron. Hence energy of magnetising and demagnetising when the speed $= 1100$ revolutions per minute $= 6500 \times \frac{1100}{60} \times 13{,}356$ in ergs per second $= 159$ watts.]

TABLE III.

	I. Degrees.	II. Revolutions.	III. Grammes.	IV. Watts.	V. Volts.	VI. Ampères.	VII. Ohms.	VIII. Watts.	IX. Watts.	X. Watts.	XI. Watts.	XII. Watts.	XIII. Watts.	XIV. Watts.	XV. Watts.	XVI. Watts.	XVII. Watts.
1	17·5°	1098	7711	4419	100·1	139·0	∞	955	895	372	0	497	464	657	16,395	289	16,684
2	5°	1094	2722	1554	103·8	41·2	18·8	105	78	400	138	55	41	148	5,015	294	5,309
3†	0°	1144	1814	1083	104·7	7·85	0	11	3	395	409	6	1	2	1,637	128	1,765

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* As previously stated, we do not propose to reproduce the curves.—EDS. ELEC. REV.

† In this experiment the direction of the current had become reversed, and No. 2 machine was generator.

In conclusion we desire to express our indebtedness to Messrs. Mather and Platt, by whom the machines we have used were manufactured, and who, in placing the same at our disposal, together with all facilities for carrying out our experiments at their Salford Iron Works, have enabled us to put theory to the test of experiment on an engineering scale.

A DAVEY-PAXMAN ENGINE TRIAL.

In our notes columns for October 29th we mentioned that we were present at a trial of a Davey-Paxman engine, which had been driving electric light machinery at the Indian and Colonial Exhibition. The full report of the test made by Messrs. W. E. Rich and Alex. B. W. Kennedy is appended.

104, St. George's Square, London, S.W.,
November 15th, 1886.

Re Trial of your 40 *H.P. Semi-Fixed Compound Engines at the Colonial Exhibition.*

Dear Sir,—I thank you for placing in my hands the commission to test these engines.

All such trials are interesting to me, and this has been so especially as very little is known yet of the actual economic performances of compound high pressure non-condensing engines, though in general recognition of their good qualities they are coming into use largely where economy is desirable and condensing water cannot be obtained.

The results of the trial detailed in the following report must tend largely, I think, to confirm the good opinions of the public regarding engines of this type.

The engines, when you first introduced me to them officially on the 20th October last, were driving two dynamos for electric lighting purposes at the Colonial and Indian Exhibition, and I learned from you that they had been working steadily day after day, through three successive exhibition seasons, on similar duties without any material repairs or overhaul; that no special overhaul of them had been made for preparing them for the present trial, which took place at the end of an exhibition season, and that consequently the present test might be taken as that of such engines in current working condition.

The normal daily duty of the engines recently has been to drive two dynamos, chiefly for charging storage batteries, during seven hours, from about 9 a.m. to 4 p.m., and then after an hour's rest, they have been started again to drive one dynamo throughout the evening.

I understood your instructions to me to be, that you would place the engines with the ordinary fireman and engine-driver unreservedly under my control, and that you desired me to carry out the most perfect test of their economical performances (especially in steam and coal consumption), which was practicable during the seven hours' run, of their ordinary daily duty, when driving the two dynamos.

I should have preferred testing them on the friction brake, as that gives the most accurate measure of the power given off by an engine; but that was impossible, as they were to do positive work in driving dynamos. Consequently, it became necessary to determine the work done from indicator cards taken at frequent intervals from the two ends of both cylinders.

Now, from a long experience in the use of the indicator, I have the highest opinion of the value of that instrument when it is in the hands of a careful and experienced operator, and all due precautions are taken to get accurate results; but I am at the same time aware that most erroneous results are often deduced from experiments made with indicators when all necessary safeguards have not been attended to.

I felt that it would be impossible for me to give close personal supervision to the taking of frequent diagrams, and at the same time keep such personal control and current records of the whole trial as would be necessary to make all the results above suspicion, and thus I was led to ask your permission to associate with me, my friend Professor Kennedy, of University College, whose experience in the testing of engines, and the use and testing of indicators, is well known in the engineering world.

His presence must add to the value of the trial, as a record of carefully ascertained facts, and deductions from them made and checked by two unprejudiced experimenters.

The trial generally (with Professor Kennedy's approval) was conducted by me on the same lines as I had originally intended, and the results, prepared and checked by us jointly, are tabulated and recorded graphically, in curves of a type which I have found by experience to give some of the best evidences of the reliability and accuracy of such records and the results deduced from them.

We provided ourselves for the purposes of the trial with a powerful staff of assistants, so that all important records were at least doubly checked, and we divided the work of supervision in the following manner:—For the operations of starting and stopping under the most uniform conditions of coal on fire, water in boiler, steam pressure, &c., to which the greatest possible importance in such trials must be attached; we both attended in the stoke-hold, and checked the facts and figures carefully with one another.

In the interim, during the currency of the trial, I devoted attention to the general control of it—the measurement and official logs of coal, feed water, steam and water gauges, counter, temperatures, &c., while Professor Kennedy directed the staff, taking and reducing the indicator diagrams; and at a table placed near the engines he plotted the records and results, with curves of increments and averages, as fast as we obtained them, so that any irregularity would have been noticed immediately, and I cannot speak too highly of the value of keeping such records up to date in such a trial.

The day was damp, indeed it was raining during the afternoon, and the steam pressure was less than that at which you desired to work. I am not prepared to give an opinion as to the amount of loss due to damp weather, but it is generally considered by practical men to be prejudicial to such a trial, and no doubt 115 lbs. steam would have given somewhat higher results than 107 lbs. In case the way in which the intermediate records during the currency of the trial have been tabulated and recorded graphically should be criticised as being unnecessarily elaborate, and leading to useless work in reductions, &c., I would have it understood that I attach great value to these frequent statistics, as they evidence distinctly whether the trial has proceeded fairly and uniformly; they enable sub-trials within the main trial to be criticised, and sometimes when an unexpected hitch occurs stopping a test altogether a short trial of sufficient length to give valuable information may be taken out of the incompleted records. The most difficult matter in such a trial is to get the fire uniform at the beginning and the end. The curves of increment (see appendix E.) are the best check on this. The longer a trial is, the less the error from such lack of uniformity.

The variation of the coal consumption, even in the long intervals shown near the top of the curve sheet (appendix E.), shows how little value can be attached to the reputed coal consumption when the trial is of very short duration.

I now beg to hand you the following joint report by Professor Kennedy and myself on the trial and its results.

I remain, yours very truly,
(Signed) WILLIAM E. RICH.

James Paxman, Esq., Colchester.

Report on Trial of Davey Paxman & Co.'s Semi-Fixed Compound Engines at Colonial and Indian Exhibition.—27th October, 1886.

Westminster, S.W., *November 15th*, 1886.

James Paxman, Esq., Colchester.

Dear Sir,—In accordance with your request we on the 27th October last carried out a trial of the economic performances of your 40 H.P. semi-fixed compound engines, which were then driving two dynamos in the south-west corner of the electric light shed at the Colonial and Indian Exhibition.

Description of Engines.—The cylinders and working gear of these engines are fitted to a bed plate placed beneath the barrel of the boiler, the cylinders themselves being side by side under the smoke box.

The cylinders are fitted with steam jackets, but at the time of the trial no steam was admitted to the jacket spaces, which were supposed to be full of dry, warm stagnant air, which would act as a non-conductor. The external cylindrical surfaces are lagged, and the boiler shell is coated with non-conducting composition.

The admission of steam to the high-pressure cylinder is regulated by a gridiron valve, the stroke of which is controlled by the governor, which actuates a block in a suspended link. The exhaust valve of the high-pressure cylinder, and the main slide valve of the low-pressure cylinder, are placed in an intermediate receiver between them.

Leading Dimensions.—The following are the leading particulars of the engines furnished to us by your firm:—

High-pressure cylinder	12¼ in. dia. × 24 in. stroke.
Low „ „	20 in. „ × 24 in. stroke.
Steam stop valve	3 in. „
Exhaust nozzle	4⅜ in. „
Steel locomotive boiler	18 ft. 4 in. long, over smoke box.
Barrel of „	4 ft. 5 in. dia. 12 ft. 8 in. long do.

Heating surface in fire box	88 sq. ft
„ tube surface, 100 tubes, 2¼ in. dia. outside, 10 ft. 7 in. long between tube plates ...	623 sq. ft.
Total	711 sq. ft.

Fire grate (ordinary) 5 ft. 0 in. long × 3 ft. 10 in. wide	= 19·2 sq. ft.
Fire grate, reduced size for trial, 4 ft. 7 in. × 3 ft. 4¼ in.	= 15·3 sq. ft.
Fire grate airs spaces between bars (total)	= 4·56 sq. ft.
Chimney	17 in. dia.

The boiler is proportioned for a working pressure of 120 lbs. to 140 lbs. per square inch, but at the time of the trial the safety valves began to blow at 115 lbs. per square inch.

Cylinders measured by us.—To be precise, we had the cylinder covers removed after the trial, and personally verified the strokes and diameters. The strokes are as stated above, but the high-pressure cylinder diameter is now 12·28 in., and the low-pressure 20·03 in. diameter, the barrels having worn slightly from continuous use; but being in excellent order. The coefficients used in calculating the power from the diagrams are based on these figures after allowing for the piston rods, which are 2¼ inches diameter. Previously to the trial we examined the pipe connections about the boiler and engines, to see that there was no connection with other boilers, and at our request the injector and its pipes were disconnected.

Coal.—The coal used on the trial was "Radford's Navigation Welsh Steam Coal" from Radford's Hafod Colliery, Rhondda Valley, and it was weighed in lots of 100 lbs. each as the trial proceeded on a new weighing machine, which was verified by us both before and during the trial.

Each lot of 100 lbs. was charged on to the fire before the next lot was served out on to the stoking floor.

Throughout the trial, the moment at which the first shovel full of each 100 lbs. of coal was served on the fire was signalled by a sharp whistle to the whole staff by Mr. Rich, and records of the condition of all the gauges, the counter, and the feed-water consumption were then taken simultaneously, and recorded in the official log.

Feed Water.—The feed was measured in a rectangular tank in which we had fitted a float gauge, so that at any moment we could see how many pounds weight of water had been previously served into the boiler. The float scale was graduated by us by pouring into the tank successive quantities of water of 60 lbs. each, weighed in the same scales as were used for the coal. The feed suction pipe was connected directly to the bottom of this tank, and was furnished with a cock which was closed precisely when the float fell to the 800 lbs. mark.

Indicators.—We found pipes fitted to each cylinder, so that the cards from both ends could be taken on one indicator placed midway between them, but our joint experiences told us that we could not hope to get reliable results taken in that manner, and we consequently had the pipes removed, and placed two "Darke's" indicators close to the respective ends of the high-pressure cylinder, and two "Richard's" indicators on the ends of the low-pressure cylinder. The former had $\frac{1}{48}$ springs in them, and the latter $\frac{1}{20}$ springs. The instruments and springs were all supplied by us, and had all been tested comparatively recently.

The four diagrams forming a set were taken simultaneously, as nearly as possible in the middle of the interval between the times at which the successive lots of coal began to be charged on the fire, as shown in the log.

Measuring Diagrams.—The indicator cards were measured in the first place during the trial by ordinates, but subsequently to be more precise, they were re-measured with a carefully tested planimeter, which gave results 1·8 per cent. less, and these last determinations have been adopted in the enclosed tables and records.

Indicators Changed.—At an early period in the trial we were somewhat nervous that the pressures at the back of the high-pressure cylinder were imperfectly indicated, as the initial steam pressure was much lower than at the front end; but the matter was carefully investigated by Professor Kennedy, and the indicator and spring were changed twice over, with results which confirmed the accuracy of the previous diagrams.

Water Gauges.—Scales graduated in inches and decimals were placed against the water gauge glasses on the boiler front, so that the variations of water level in the boiler could be recorded precisely. The alterations of level in the gauges were very gradual throughout, without any of the rapid alterations sometimes noticed on such trials. The steam supplied to the engines was apparently remarkably dry all day.

Variations in Weight of Water in Boiler.—The area of the boiler at mean water level during the trial was measured, and the weight of water in it, at the mean steam temperature, corresponding to each one-tenth of an inch on the scale, was thus estimated at 31 lbs., and allowed for in determining the weight of steam used, as shown in the tables.

Preparations for Start.—On the 27th October the engines were started at about 9.15 a.m., and were due to stop at 4 p.m. We desired to get as long a trial as possible, under uniform conditions, out of the intervening 6¾ hours. At first the resistance of the dynamos was low, and the engine power was constantly increasing for a considerable time after the start. As soon as the normal resistance was reached we stopped further firing and feed, swept the stoking floor clear, and together watched the pressure gauge till from the lowering of the fire (which we also inspected from time to time) it fell to 100 lbs. per square inch.

Trial Started.—At that moment, viz., 10.12 a.m., the first signal was given, the counter, which stood at 0, was thrown into gear, the gauges were all noted, and the first shovelful of the first 100 lbs. lot of coal was put on the fire. The feed tank was full, and shortly afterwards we began to charge measured feed water into the boiler, and at 10.20 the first set of diagrams was taken. Records at frequent intervals, as described above, and shown in abstract log of trial, followed for 5 hours 42 minutes. At 12.30 the fireman began to use some of the few ashes which had accumulated in the ash-pit since the start.

Trial near Completion.—At 3.26 we told him that the 100 lbs. lot of coal then commenced would be the last served out to him and that he must make the most of it and the ashes which remained. At the same time we arranged so to adjust the feed service as to get back the water in the boiler as nearly as possible to the level at which we started.

End of Trial.—When at last the fire became unequal to make the steam demanded by the engines, the steam pressure began to fall and we together watched it narrowly till on its reaching 100 lbs. exactly, the final signal was given, the counter was pulled out of gear, the gauges and water tank consumption were all taken, and the trial was at an end, viz., at 3.54 p.m., having lasted 5 hours 42 minutes.

Uniform Running.—During the whole trial the engine power speed, steam pressure, &c., were remarkably uniform, the steam was dry, and there was no hitch or inconvenience of any kind

APPENDIX B.—TABLE II.—RESULTS OF TRIAL.

Time.	INCREMENTS SINCE LAST READING.					TOTALS SINCE START.					AVERAGE SINCE LAST READING.					Units of evaporation or lbs. of water at 212° evaporated at 212° per lbs. of coal.	Coal burnt per sq. ft. of grate surface per hour.	Grate surface per I.H.P.	Heating surface per I.H.P.
	Number of minutes.	Counter.	Coal in lbs.	Weight of steam used in lbs.	Ft. lbs. of work indicated in millions of ft. lbs.	Number of minutes.	Number of revolutions.	Coal served on fire previously to this reading.	Weight of steam used in engines.	Ft. lbs of work indicated in millions and decimals.	Revolutions of engines per minute.	Indicated H.P.		Weight of steam used in engines per I.H.P. per hour.	Coal burnt per I.H.P. per hour.		Grate area 15·3 sq. ft.		Heating surface 711 sq. ft.
												For short intervals.	For long intervals.						
10 12 A.M.	...	0	commencement of trial.																
10 25 ,,	13	1340	100	...	49·4	13	1,340	100	...	49·4	103·1	115·2	116·5	23·42	2·45	11·39	18·7	·131	6·1
10 51 ,,	26	2690	100	1689	100·9	39	4,030	200	1,689	150·3	103·5	117·6							
11 12 ,,	21	2180	100	1035	80·7	60	6,210	300	2,724	231·0	103·8	116·4							
11 36 ,,	24	2480	100	1101	92·4	84	8,699	400	3,825	323·4	103·3	116·7							
11 57 ,,	21	2190	100	921	75·4	105	10,880	500	4,746	398·8	104·3	108·8	108·8	23·92	2·54	11·32	18·0	·141	6·5
12 20 ,,	23	2400	100	1071	84·6	128	13,280	600	5,817	485·4	104·3	111·5							
12 42 P.M.	22	2280	100	939	77·6	150	15,560	700	6,756	561·0	103·6	106·9							
1 3 ,,	21	2200	100	840	74·6	171	17,760	800	7,596	635·6	104·8	107·6							
1 23 ,,	20	2080	100	950	69·0	191	19,840	900	8,546	704·6	104·0	104·6	105·7	24·95	2·80	10·69	19·4	·145	6·7
1 46 ,,	23	2390	100	953	81·3	214	22,230	1000	9,499	785·9	103·9	107·1							
2 2 ,,	16	1680	100	749	57·6	230	23,910	1100	10,248	843·5	105·0	109·1							
2 24 ,,	22	2280	100	909	74·7	252	26,190	1200	11,157	918·2	103·6	102·9							
2 46 ,,	22	2290	100	998	77·9	274	28,480	1300	12,155	996·1	104·1	107·3	106·8	24·44	2·50	11·91	17·4	·143	6·7
3 8 ,,	22	2300	100	904	77·5	296	30,780	1400	13,059	1073·6	104·5	106·7							
3 26 ,,	18	1870	100	751	62·3	314	32,650	1500	13,810	1135·9	103·9	104·9							
3 54 ,,	28	2900	100	1261	99·4	342	35,550	1600	15,071	1235·3	103·6	107·6							
5h. 42m.	342	...	...	15,071	1235·3	...	...	...	...	Averages.	103·9	109·5		24·18	2·57	11·33	18·3	·740	6·5

from beginning to end. No handle about the engine was touched excepting that on the feed suction cock and the water gauge cocks, the steam starting valve was wide open, the speed being controlled solely by the governor. The fireman regulated his fire and the feed water to meet the current requirements of steam. Beyond the observations recorded, our assistants took many intermediate records, which on being plotted, have been found to further confirm the accuracy of those given in the official log. The logs and results are given in extenso in Appendices* A. Table I., abstract log of trial; B. Table II., result of trial; C. specimens of indicator diagrams; D. expanded diagrams with adiabatic curve; E. diagrams showing curves of increments and averages and the general results of the trial graphically.

The following is a summary of the results:—

Duration of Trial.—5 hours 42 minutes = 342 minutes or 5·7 hours.

Totals:—	
Revolutions	35,550
Coal served on fire	= 1,600 lbs.
Weight of steam used in engines	=15,071 lbs.
Foot lbs. of work indicated	=1,235·3 millions.
Number of sets of indicator diagrams ...	17
Averages:—	
Steam pressure in boiler	=107 lbs. per sq. in.
Revolutions per minute	103·9
Indicated pressure in high pressure cylinder	37·2
„ „ „ low „ „	13·89
Indicated horse-power high press.	54·6
„ „ „ low „	54·9
Total	109·5
Weight of steam used in engines per indicated horse-power per hour	24·15 lbs.
Coal burnt per 1 H.P. per hour	2·56 lbs.
Water evaporated per lb. of coal	9·42 lbs.
Mean temperature of feed	55·5°
Units of evaporation or equivalent weight of water at 212° evaporated at 212° per lb. of coal	11·33
Calorific value of coal used as per mean of six experiments with calorimeter at University College	13·9
Efficiency of fireman, furnace, and boiler $= \frac{11{\cdot}33}{13{\cdot}9}$	=815
Coal burnt per square foot of reduced grate per hour	18·3 lbs.
Grate surface per indicated horse-power ...	·14 sq. ft.
Heating surface „ „ „ ...	6·5 sq. ft.

The above results speak for themselves. We consider them eminently satisfactory for high pressure engines in regular work without any special preparation for trial.

We remain, dear Sir, yours faithfully,

(Signed) WILLIAM E. RICH, *Member Institute, C.E.*
ALEX. B. W. KENNEDY, *Member Institute, C.E.*

ALLEGED FRAUDS ON AN ELECTRIC LIGHT COMPANY.

THE Brighton magistrates were engaged for a considerable time last Friday in investigating allegations of fraud against Frederick Dowland (45), and Percy Robert St. Quentin (34), the former being charged with stealing cheques of the value of £322 4s. 6d., belonging to the local Electric Light Company, in whose employ he had been as secretary, and the latter with being an accessory after the fact. Both prisoners had been remanded from the previous Saturday. On November 4th a cheque was sent to the Electric Light Company by the London, Brighton, and South Coast Railway Company, the amount being £200. The letter in which it was contained was opened by the prisoner, by whom a receipt was forwarded some four days afterwards. On the same day Dowland called at the Western Branch of the Capital and Counties Bank, and after presenting his card stated that he wanted to open an account there. He then handed to the cashier the cheque for £200, which, although made payable to the Electric Light Company, or order, he endorsed on the back as secretary, and at the same time he deposited £7 in cash. Having obtained a cheque-book he left. On November 5th a cheque for £13 10s. was paid to Dowland, who at once gave a receipt, and it was also proved that other cheques bringing the total value up to £322 4s. 6d. were received by him and never accounted for, although they ought to have been at once paid over, the prisoner having no authority to endorse cheques on behalf of the company. On the 10th instant a man, believed to be St. Quentin, called at the bank and paid in £108 14s. 6d. to Dowland's credit, this sum being composed of cheques for £11 4s. 6d. and £97 11s., proved to have been received by Dowland on behalf of the company. At the same time the man presented a cheque drawn by Dowland for £5, which was cashed. Later on in the same day Dowland himself came into the bank and said that he wanted £250 from his account to pay over to the Electric Light Company. The cashier referred to his books, and having ascertained that there was £315 on the account, paid the money which was taken in gold. It was understood at the bank that it was a "collecting account."

Evidence was called with the view of proving that St. Quentin had tried to cash cheques, and that he had knowledge of the alleged robbery.

On the afternoon of the 10th information was sent to the Electric Light Company that Dowland had withdrawn £250 from his account, and the next morning a warrant for his arrest was obtained. Both prisoners had absconded, and they were known to have visited London together, passing under assumed names. On the afternoon of the 11th prisoners were arrested at Folkestone. Altogether it was believed that the defalcations amounted to £500, and in the possession of the prisoners (chiefly in a bag) was found nearly £250. Prisoners reserved their defence, and were committed for trial at the Quarter Sessions, bail being refused.

A TELEPHONE OF 1868.

AN "electro-phonetic receiver," for use in telegraphy, invented by Royal E. House, and patented by him in letters patent No. 77,882, of 1868, is described by the *Scientific American*. This name was given it by the inventor. It is really a telephone.

A box of generally cubical form has one end closed with a diaphragm. Two slender bars of metal are attached to the diaphragm, one near the centre, the other below it. These bars the inventor terms "limiters." The upper limiter limits the motion of an armature working over a magnet, so that it cannot come in contact with the poles. The other limiter prevents the armature from receding too far from the poles. The armature is pivoted at one end. Its inner and free end strikes the lower limiter; it is provided with an extension at the pivoted end that extends upward at right angles to the armature. The end of this arm bears against the upper limiter. An electro-magnet operates this armature, and is situated below it in the bottom of the box, and is connected to binding posts. A tension spring is used to adjust the pull of the pivoted armature away from the magnet.

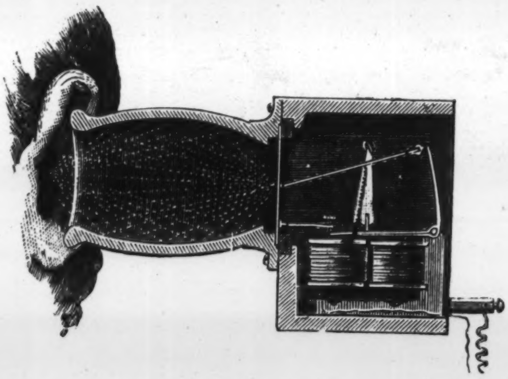

FIG. 1.—ROYAL E. HOUSE'S TELEPHONE OF 1868.

The box has attached to it an ear trumpet or reflector that surrounds and extends outward from the diaphragm. Both limiters have adjusting screws. By these their freedom of movement may be varied. They can be adjusted so that they will be in contact one at a time only with the armature and arm. In this case a make and subsequent break, or corresponding and considerable changes in intensity of current, will produce two blows, the first on the upper limiter and the second on the lower. On the other hand, by screwing out the limiter screws to a fuller extent, this oscillation will be gradually reduced until no break is possible. Then makes and breaks of the current, or variations in intensity, will no longer produce blows, but a true telephonic sound on the diaphragm. If connected in circuit with a microphone transmitter, it will talk; and if two are connected having closed or ground circuit with battery, or if steel or cast iron magnet cores are used without any battery, they will act as receivers or transmitters, and form a complete telephonic system.

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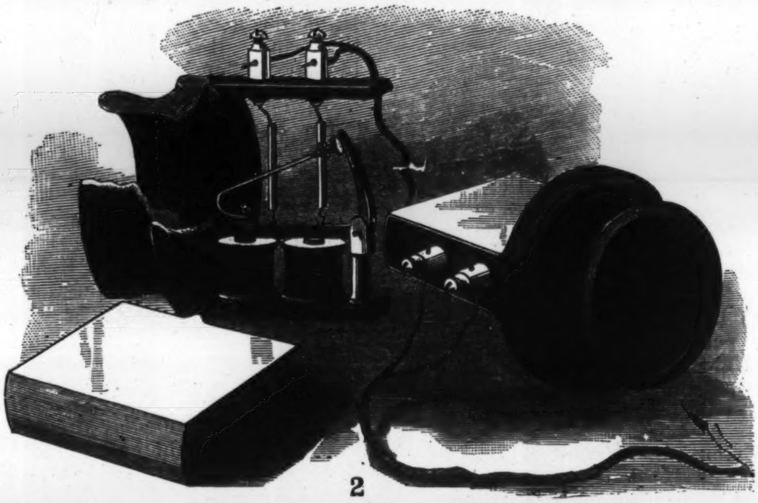
* Of these we only reproduce Appendix B.—EDS. ELEC. REV.

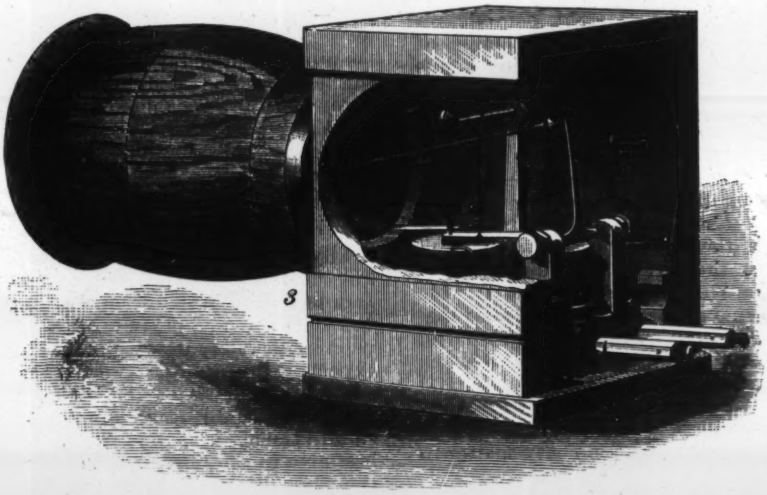
The apparatus is a perfect telephone, immeasurably superior to anything shown in the Bell patents of 1876 or 1877. The subject of figs. 1 and 3 of our drawing is a reproduction of the model accompanying the patent, which model was destroyed in the Patent Office fire Its sides in the elevation are broken away to show the interior construction. In the section it is shown in use as a receiver. The inventor's idea of his ear trumpet was that it should operate as a reflector of sound waves. He gives directions for constructing the interior surface of such form as to reflect the sound waves to a focus to be occupied by the listener's ear. For this end he directs the use of mirrors to reflect light, thus to determine experimentally the proper curve.

An interesting feature in this instrument is the way it lends itself to the use of any material for the diaphragm. In this respect it resembles strikingly Bell's instrument of the 1876 patent. In both of the systems the armature is distinct from the sounding part. The inventor's idea was, if desired, to use large diaphragms. Some as large as 8 inches in diameter have been constructed, this size being specified in the patent, and work very well. It is easy to discern in the instrument a great flexibility as to size, material, and other modifications, its system of adjustment is so complete.



2

HOUSE'S MODERN PHONETIC TELEGRAPH.



3

ROYAL E. HOUSE'S TELEPHONE OF 1868.

The two figures described above are exact copies of the patent drawings. To adapt it to modern use some minor changes in proportions and material have been introduced, which are illustrated in fig. 2. The frame or body is constructed of cast iron. The magnet cores are screwed into one arm of this frame, and bobbins are placed around them. An ebonite ear or mouth piece screws on the open end of the frame, and clamps the metallic diaphragm in position. This ear piece is made shorter than was the corresponding part of the model of the patent. A two-branched limiter is substituted for the pair of separate limiters of the original. The result is a more compact instrument. A cover of brass or German silver incloses the principal working parts. Binding posts are attached to one of the arms of the frame opposite to the magnets. Thus the frame forms the back piece of the magnet. The double limiter is provided with adjusting screws. This instrument is a serviceable, distinct telephone. We (*Sc. Am.*) very recently were present at a trial of its capacity over a fair length of line. Four Leclanché cells were in circuit. The same instruments were used for receivers and transmitters. The action was perfect. There was no choice of sounds. Sibilants were as clearly transmitted as any other utterances. The writer in listening to them had several standards. He had listened to one of the first of the Bell telephones in 1877 or thereabouts, at the Stevens Institute in Hoboken. The other standards were reproductions of the Reis telephones, which he had also experimented with. The House telephone was far superior to either of these. Its work was fully as good as that of the Bell telephone and Blake transmitter of to-day. The modern instruments, it will be noticed, do not differ except in constructive detail from the device of the patent. They are a true reproduction of it. It is most interesting to place the name of the inventor of the first printing telegraph by the side of Reis, Edison, Bell, and Gray, as the inventor and constructor of one of the early telephones.

The Wallace Telephone Company, of 150, Broadway. N.Y., will soon be prepared to supply these instruments.

NOTES.

Railway Lighting.—Commencing with the first of the current month, the first and second class carriages on the Wurtemberg railways are to be electrically lighted.

Town Lighting.—The French provincial town, Domfront, is to be lighted by Edison lamps, which will supplant the existing petroleum street lamps, 52 in number. The new light will be supplied by the undertakers for the annual sum of 6,300 francs, in lieu of 7,000 francs hitherto paid for oil lamps.

Electric Lighting Extension.—Messrs. S. C. Lister and Co., Manningham, Bradford, in furthering their determination to extend the use of electric lighting, have just had 12 more 1,000-candle arc lamps brought into use. This brings the total of electric illumination at these mills up to 91,000 candles.

Gas Abandoned.—Mr. Thomas Speight, commission wool comber, Bradford, has had four arc lamps of 3,000 candle-power each, and 60 incandescent lamps brought into use at his works, and he proposes, by introducing 50 more incandescent lamps, to do away with gas altogether.

The Electric Light at the British Museum.—According to the *Morning Post* of Tuesday on the previous evening at the British Museum at 10 minutes past 7 o'clock, the stillness of the reading room was broken by a peremptory call on the part of the librarian that all books should be returned with the greatest possible despatch, as the electric machinery had gone wrong, and the light could not last out more than ten minutes. In a scene of the greatest hurry and confusion the books were handed in before the darkness was complete, and the readers all quickly departed. Owing to the construction of the library, which is circular, and the exit extremely small, it would have been no easy matter to have found the way out in total darkness.

Electric Lights in Liverpool Streets.—The electric light for street use has been a decided failure in Liverpool, says the writer of "Science Notes" in the *Liverpool Mercury*, but private firms seem to succeed with it, and the lighting of such places as the Picton Reading Room seems to be all right. Why the streets cannot be fully illuminated by the same method is a mystery to most people. To look over the list of towns which are now lit up by electricity, and to see the electrical activity in places we look upon as uncivilised, is enough to make one think that we are behind the times. The tumbling river Angeraph has lighted the little village of Darkehmen in Western Prussia, and why cannot Liverpool be lighted by the strong tidal forces of the Mersey? The problem seems a simple one, and there is no doubt but that we are moving rapidly towards its solution. (We hope it is so.)

Present Position of the Electric Lighting Industry in Berlin.—It is said that 20,900 incandescent lamps are now used in the capital of Germany; of which 15,900 are fed from six central stations, while the remaining 5,000 lamps belong to isolated plants. In addition to these must be counted a great number of arc lamps, which illuminate Leipziger Strasse, the railway stations, markets, the Exhibition Park, and other public places. This progress is all the more apparent when comparison is made with the amount of electric lighting done in London where the adverse laws have put a stop to enterprise, and in Paris where the gas monopoly similarly retards progress. As regards Europe the city of Berlin takes the lead in electric lighting, and New York is the only city in the world which surpasses Berlin in this respect. Numerous new installations are in course of construction, and all over Germany the electric lighting industry is flourishing.

The Electric Light at Tavistock.—The illumination of Tavistock by means of the electric light having been carried out for a fortnight by way of experiment, a meeting of the inhabitants was held last week for the purpose of hearing an address by Mr. Wharton (of the firm of Laing, Wharton and Down, electrical engineers) on the system of electric lighting which he favours, and also to consider the question of the future lighting of the town. There was a large and influential attendance, and the Guildhall, where the gathering took place, was beautifully illuminated by means of electricity. Mr. Wharton stated that, roughly speaking, some £2,000 would start an installation in the town and allow for some dozen lamps for private use. The dynamo would cost but a few pence for repairs. His firm would light the town publicly for about the same sum as the gas company now charged. The cost of each street lamp would be £15 per annum, and about 20 arc lights with 50 or 60 gas lamps would suffice to properly light the town. If a company were formed, as had been suggested, he was so confident of its success that he was prepared to take payment to the extent of 50 per cent. in shares. A resolution was eventually carried with unanimity to the effect that the meeting was of opinion, having in view the great success of the experiments and the explanations given by Mr. Wharton, that steps should be taken for the permanent introduction of the light into Tavistock, provided that the cost be satisfactory, and that a committee of investigation be formed.

Electric Lighting in Birmingham.—It has been known for some time, says the *Gas World*, that the Incandescent Electric Lighting Company has failed to "raise the wind," or, in other words, to secure capital wherewith to lay down plant, and to demonstrate to an expectant multitude that electric lighting, when carried out on an extensive scale, is cheaper than gas. Three years ago the Birmingham Corporation gave a concession to the above company of what is regarded as the best area in the town; but, owing to scarcity of funds, the "installation" has never been undertaken. Since this concession great progress has been made in perfecting the mechanism connected with the generation of the electrical current, and it is well known that much agitation has taken place in high quarters to get the law applicable to electric lighting altered. Taking these matters into consideration, the Town Clerk of Birmingham, reporting to the Electric Lighting Committee of the town, questions whether it is wise to allow the company to remain in practical possession of the field, and the committee has asked, and has obtained, powers to apply to the Board of Trade to get the Provisional Order revoked.

Lighting of the "Liberty" Statue.—A daily paper states that the United States Government has ordered arrangements to be made for the lighting of Bartholdi's statue of "Liberty."

Electric Lighting of Country Mansions. — With reference to a recent notice respecting the introduction of electric light into Mr. W. H. Smith, M.P.'s country house at Greenlands, near Henley-on-Thames, we are requested to state that the sole contractors for the work were Messrs. R. E. Crompton & Co., of Chelmsford, acting under the direction of Messrs. Musgrave Heaphy, C.E., and W. H. Massey, C.E., Mr. Smith's consulting engineers.

The Electric Lighting Act.—In the coming session of Parliament a Bill will, we understand, be introduced for the amendment of the Electric Lighting Act of 1882.

Electric Lighting in Bradford.—One of the most intelligent articles upon electric lighting we have ever seen in the daily press, whether metropolitan or provincial, is that which appeared in a recent issue of the *Bradford Observer*. Perhaps an explanation is to be found in the fact that the proprietors of that journal have been sufficiently enterprising to become personally acquainted with the electric method of illumination, for the offices of the paper have been fitted with incandescent lamps for some time. The article states that in Bradford electric lighting is for the most part confined to factories, warehouses, or dyehouses, where the finishing and examination of materials or the matching of colours has to be carried on, and proceeds to give a tolerably extensive list of the firms which have adopted the system. In nearly all the factories the dynamo is driven from the same engine which supplies the motive power for the other machinery, and generally with satisfactory results, although the most successful instances are those in which a separate engine is used.

Electric Lighting in the City.—The London and River Plate Bank have for some time past been considering the question of electric lighting, and at their last board meeting it was decided to take immediate steps in the matter, and to entrust the work to Messrs. Drake and Gorham.

Mr. F. J. Whiting, 7A, South Place, Finsbury, numerical and general printer on a large scale, has his premises lighted by Swan lamps. The motive power is an Otto engine. A Gramme dynamo, made by Walker and Olliver, supplies the current. The installation was carried out by Messrs. Heap and Stuart.

Gas Works and the Electric Light.—The Town Council of Croydon is agitated over the proposed purchase of the works of the Croydon Gas Company, and, although the majority of the councillors are in favour of the scheme, there are several who oppose it on the ground that it would be unwise, in view of the progress which electric lighting is making. Alderman Barrow, the deputy mayor, had taken the trouble to gather the opinions of members of the corporations of towns where electric lighting has been introduced, and, as the result of his exertions, he was able to tell a very dismal story from the point of view of electric lighting interests. The Mayor of Hastings said the electric light was an utter failure, and added, "obtain the gas works by all means." Alderman Sendall, of Brighton, said, "Go on. We have lost all our money. The thing is a failure, and it will cost us many hundred pounds to make good our former position." "Go on with your purchase of the gas works," said a Portsmouth alderman, "the electric light is a failure." We should like to know how many of these opinions were disinterested.

The Electric Light at Bazaars.—The members of the Exeter Literary Society are organising a bazaar at which the electric light and other electrical effects are to form a prominent feature. Messrs. Shippey Brothers are supplying the lamps and carrying out the installation.

The Electric Light at Hell Gate.—Acting-Secretary Fairchild gave orders on October 28th for the extinguishment of the electric light in the tower at Hell Gate, New York Harbour, from and after December 1st. This action was based on the recommendation of the Lighthouse Board, and because of complaints from mariners that the dazzling character of the light made it a detriment instead of an aid to navigation.

The Fires at Hampton Court Palace.—In a correspondence which is taking place upon this subject it is suggested that the danger of a recurrence of these fires may be obviated by the adoption of the electric light for illuminating the Palace. At present paraffin oil lamps are used. One correspondent writes from the Junior Carlton Club :—"Has it occurred to the mind of the First Commissioner of Works that the river which flows idly by might supply the means of economically lighting the Palace with electric light ?"

Telephone Conversazione at Glasgow.—The annual *conversazione* of the employés of the National Telephone Company at Glasgow, took place last Friday evening in the St. Andrew's Halls, a numerous company of ladies and gentlemen being present on the occasion. After a musical promenade, the dance was started to the strains of an excellent quadrille band. During one of the intervals, the chairman of the company, Colonel R. Raynsford Jackson, of London, who was accompanied by Sir Wm. Thomson, Mr. J. L. Mitchell, Mr. Wm. Alexander Smith, resident director ; Mr. D. Johnstone Smith, secretary ; and Mr. J. E. Watson, ascended the platform, and delivered an interesting address on the progress which the telephone was making in the public estimation. Five and-a-half years ago, he said, there were only 317 subscribers in the Glasgow district, whereas now they had no fewer than 1,857, while the company at present had 137 offices, as against 33 five and-a-half years ago. At that period, too, the total number of messages sent in a year was 688,000, while now the dispatches sent in a year reached the high total of 5,020,000. He considered the telephone service in Glasgow was as perfect as it could be. The dance was afterwards resumed, varied now and again with a song, and an altogether most enjoyable entertainment concluded at an early hour in the morning.

The Telephone a Blessing. — The telephone has proved a great blessing in many curious ways. In one Connecticut telephone office during the last three years 18 girls have married subscribers on the line. The 18 subscribers have displayed a praiseworthy fondness for ringing telephone belles.

Telephoning between Paris and Brussels. — A Central News Brussels correspondent says :—A convention has been signed between France and Belgium, providing for the establishment of telephone lines between Paris and Brussels. The work will be taken in hand at once, and it is hoped everything will be finished by January next. The charge for the use of the telephone between the two capitals will be 3 francs for five minutes' conversation.

A New Use of the Duplex.—Two patents were issued a fortnight ago to Mr. Lucius J. Phelps on duplex telegraphy. Under these inventions it is claimed that the same wire used for telegraphing to or from trains may be worked "duplex," thereby enabling it to be used as an ordinary Morse wire between stations and simultaneously used for telegraphing to and from moving trains. The system is to be immediately applied by the Phelps Telegraph Company upon the Lehigh Valley Railroad.

Suicide of a Telegraph Clerk.—James Parrish, a telegraph clerk at the Chief Office of the City Police, Old Jewry, committed suicide by hanging himself on Tuesday. Ill-health and domestic bereavement are supposed to have unhinged the poor fellow's mind.

Telegraph Stores Wanted.—Tenders are invited for the supply, during the six months ending June 30th, 1887, to the North-Eastern Railway Company, of telegraph apparatus and telegraph wire and line stores. Payment for each month's delivery will be made at the end of three clear months, or in cash less 2½ per cent. discount. Forms of tender may be obtained on application to Mr. Graves, Telegraph Department, York; and tenders must be sent to the Secretary, at York, by noon on December 1st.

Jubilee of the Telegraph.—As the electric telegraph was first successfully worked in England in 1837, next year will be its jubilee; and "as no entertaining account of its humble origin and marvellous progress has yet been published," this want is to be supplied by Messrs. Bell & Sons, who are about to issue the first volume of "Lives of the Electricians," written by Mr. W. T. Jeans (author of "The Creator of the Age of Steel"). This volume, containing biographies of Profs. Tyndall, Wheatsone, and Morse, is to give an account of the remarkable circumstances in which the telegraph originated, and of its not less remarkable progress to the present time. The first practical telegraph was worked between Euston Station and Camden Town on July 25th, 1837—the month after the Queen came to the Throne—and it is the invention which has made the greatest mark on the Victorian era.

The International Cable Company.—The International cable scheme is once more before the public, and the *Financial News* advises investors to make careful examination into its merits before applying for shares. Under various guises, such as the "American, British and Continental Cable Company," the "Merchants' Mutual Cable Corporation," and so on, it has been from time to time brought forward, but ill-success seems to have dogged the steps of its promotors. The publicity which we as well as others have given to the fact that several gentlemen whose names appeared as directors on a prospectus or a letter inviting applications for shares which was circulated in several Continental cities had disclaimed any connection with the company will scarcely assist those now interested in floating the concern in their designs upon the investing public. A few other peculiarities are revealed when the present prospectus is compared with one issued some little while ago. But even providing the *bona-fides* of the company are unimpeachable, we are not at all impressed by its prospects should it ever enter upon commercial operations. The capital asked for is £1,000,000, a singularly small sum for an Atlantic cable company; but an explanation of the seeming modesty of the promoters is perhaps to be found in the following paragraph:—"The present issue of capital will be applied, in the first place, in laying the cable between Portugal and the Azores, and between the Azores and the mainland of America. The balance will be applied to the completing of the other sections, *together with such further capital as may be required, which will be raised by a further issue of shares or by debentures.*" We agree that the capital is "comparatively moderate," but how that fact can logically be urged, after the language of the foregoing, as a "special advantage" rendering possible the adoption of low rates we are not quite able to comprehend. Mr. Weaver, the managing director of the Anglo-American Telegraph Company, has written to the papers giving a few figures illustrative of the probable returns the new company would get should its cables ever be laid. He states that the total Atlantic cable traffic at the tariff of 6d. per word yields £300,000 per annum. Presuming that the new company lays two cables its proportion will be 20 per cent., or £60,000 per annum; if it lays only one cable its proportion will then be only £30,000, which, irrespective altogether of the question of the capital cost of the cables, would only be sufficient to pay working expenses and repairs, leaving nothing either for renewal fund or dividend. These are conditions, we imagine, which will invite very few investors. A pregnant fact which Mr. Weaver gives is that there are five companies with ten cables struggling to get a living out of the Atlantic cable traffic, and four of these are earning no dividends to his certain knowledge, whilst the fifth must be having a pretty hard time of it. In replying to the statements of Mr. Weaver the solicitors of the International Company use the argument that the cables already established were constructed at a time when the cost of material and manufacture was much greater than it is at the present time, and they add that they anticipate a large revenue from the West Indian connection. There may be something in the matter of cost, but the difference will not be so great as to materially affect the position; and the revenue to be derived from the West Indian islands, in view of the existence of cable companies with connections there, is, we are assured, of the most meagre kind. The position of the Mackay Bennett Company is quite different from that in which the International would be placed, and no comparison should be made between these two. It is not clear by what means the new company intends to surmount the difficultiy respecting land lines, the telegraph companies on the other side being practically in the hands of the existing cables. We do not believe the new company will ever receive sufficient encouragement to justify it in laying its cables.

The Irish Telegraphic Cables.—A new cable between England and Ireland is to be laid, the shore end joining this country at Nevin, in Carnarvonshire. The postal telegraph ship *Monarch* has buoyed the old Irish cable off Rhydwyn, Holyhead, and will take the cable to a safer and better landing place at Rhosneigr. Messrs. Lumsden and Culley, the postal telegraph submarine superintendents, are in charge of the operations. The old cable, which has been greatly damaged by the storms, will be thoroughly overhauled before being relaid.

New Zealand Cables and Bulgaria. — Exeunt Kaulbars! "The Bulgarian difficulty is on a fair way to settlement by the retirement of General Kaulbars from the field of action. The New Zealand telegraph matter is also settled temporarily by the suppression, until the assembling of the New Zealand Parliament, of the claims of the Eastern Extension Company. *Sic transit gloria mundi.*"

An Electric Gong.—Messrs. Cox-Walker & Co., of Darlington, have just completed the erection at the Holloway Sanatorium at Virginia Water, of the largest electrically-beaten gong in this country. It is placed at a height of over 80 feet on one of the lantern towers. An ordinary press button which can be used by any of the attendants is fixed on the ground floor, and the resulting "boom" can be heard in the little village of Stroude, about half-a-mile distant. Messrs. Cox-Walker & Co. have also made and fixed several other of their "protected Chinese electric gongs" of smaller size in the same building for various purposes. The firm is busy at the present time with the largest tell-tale it has yet made. It is for the Durham County Asylum.

New Electrical Firm.—We now find that the rumours we published with reference to Messrs. Drake and Gorham, the late managing engineer and works' manager to the Storage Company, were somewhat premature, and that they are establishing themselves as electrical contractors with offices at 2, Prince's Mansions, Victoria Street, S.W. We have no doubt, however, that they will in some way continue their connection with accumulators.

Physical Society.—At the last meeting of this society (November 13th) a vote of condolence with Mrs. Guthrie on her sad bereavement by the death of Prof. Guthrie, F.R.S., the founder of the society, was passed unanimously. No electrical subjects were dealt with at the meeting.

American Society of Mechanical Engineers.—The seventh annual meeting of this society will be held in New York during the coming week. On Wednesday the members will respond to an invitation from Mr. Edward Weston, of the United States Electric Illuminating Company, to visit his private laboratory at Newark, N.J. Mr. Weston's laboratory is one of the best-equipped electrical laboratories in the world.

A Modern Substitute for the Rack.—A burglar who was captured down in Oxford a few days ago refused to give any account of himself. A galvanic battery was applied, and the man became voluble. He eventually gave a name and an address; but how far they were correct we have yet to learn.

Portrait of Dr. Guthrie.—An excellent portrait of the late Prof. Guthrie is published, by permission, by Mr. White, photographer, Littlehampton.

The Blackpool Electric Tramway Company.—In our City columns will be found an abstract of the second annual report of the directors of this company.

Fire Extinguishers.—Shortly after half-past eight o'clock on Thursday morning last a fire broke out in the basement of the large premises occupied by the Medical Battery Company at the corner of Rathbone Place, Oxford Street. The flames were extinguished with the liquid contents of Harness's Ready Fire Extinguishers.

Accident from Overhead Wires.—Much consternation was caused in Belfast last week by the fall of a portion of the Albert Memorial erected in 1869 to the memory of the late Prince Albert. It appears that some men of the engineering department, Postal Telegraphs, were fixing wires along the side of the memorial, when it caught one of the pedestals, almost half a ton in weight, over the statue, and pulled it down. The memorial is in the busiest part of the city, and some men passing had a narrow escape.

The Thames Conservancy and Electric Bills.—A Parliamentary return shows that during the sessions 1883-4-5 the Thames Conservancy Board spent £5,349 9s. 1d. in opposing or promoting Bills and Provisional Orders in Parliament. Of this amount, £23 6s. 2d. was for opposing the Charing Cross and Waterloo Electric Railway Bill (1883); £39 13s. for opposing the Electric Lighting Companies' Provisional Order (1883); £19 0s. 8d. for opposing the United Telephone Company's Bill (1884); and £11 15s. 3d. for opposing the United Telephone Company's Bill (1885); total £54 2s. 1d. It is interesting to note, by the way, that with the exception of £1,867 2s. 6d. which went for the promotion of the Thames Navigation Bill, all the money spent by the Board was for opposing Bills. The Great Yarmouth Port and Haven Commissioners opposed the Provincial (Brush) Electric Light and Power Company's Provisional Order in 1883, at a cost of £10; while the Aue and Calden Navigation Trustees expended £3 14s. 2d. in opposing the Leeds Corporation Electric Light Provisional Order; £3 14s. 2d. in opposing the Bradford Corporation Electric Light Provisional Order; and £3 10s. 2d. in opposing the Wakefield Corporation Electric Light Provisional Order; total, £10 8s. 6d.

Covent Garden Circus.—Messrs. Paterson and Cooper have secured the contract for lighting by electricity the circus in Covent Garden Theatre, on and after Boxing Day.

Primary Batteries.—We learn that Prof. George Forbes is preparing for the "Specialist" series a volume on primary batteries.

A New Company.—In Paris a new electric light company is to be formed under the auspices of the banking firm of Stern & Co., with a capital of 10 million francs.

Personal.—It is stated that Sir Daniel Gooch, who was made a baronet in 1866, in recognition of his services in connection with the laying of the Atlantic cable, is likely to be made a Peer on the occasion of the opening of the Severn Tunnel by the Great Western Railway Company. Sir Daniel is chairman of that company.

Electric Railway.—It is intended to construct an electric railway over the Trachenberg mountain, Germany.

Junior Engineering Society.—At the last meeting of this society, a paper was read by F. Harman Lewis, Stud. Inst. C.E., on "The Electrical Government of the Steam Engine." The author having indicated the particular necessities for and requirements of steam engine governors, proceeded to show as an illustration of the importance of perfect regulation how great was the demand for accurate and sensitive regulation of speed for dynamos, and pointed out the various respects in which the centrifugal governor had failed to comply with this demand. Electrical devices for governing the speed of dynamo machinery motors were then considered, and Jamieson's, Richardson's, and Willans's electrical governors were described, the author claiming for the latter certain advantages which the others did not possess, the most noticeable being its great freedom from friction. From statistics of the efficiency of this governor from readings taken between 5 p.m. and 9 p.m. at the Edison and Swan installation at Victoria Station, it appeared that although the current ranged from 230 to 500 ampères and the boiler pressure from 85 to 105 lbs. per square inch, the electromotive force varied only ·5 volt. The paper was illustrated by some excellent wall diagrams, and a specimen of the Willans governor kindly lent by its inventor.

Gold in Paris Streets.—M. Popp, "a gentleman well known in the French scientific world, and the inventor of the pneumatic clock and of an apparatus for the production of the electric light by means of compressed air motors," is defending himself in an action now progressing in France against allegations that he obtained 445,000 francs by representations that he had discovered gold, silver, and aluminium in the stone underneath Paris. M. Laglaine, an analytical chemist, called for the defence, stated that he had made numerous experiments with the stone, and had proved that it contained from 3 to 240 grammes of gold per 1,000 kilos. (about half a pound per 2,000 lbs.), and silver in still larger quantities. Oh, happy Paris!

The Illumination of the Dardanelles.—A telegram from Constantinople, last week, stated that the electric light on the heights of Siddul Barhar, at the entrance of the Dardanelles, has been completed, and has given so much satisfaction to the military authorities that further apparatus of a similar kind has been ordered for the other fortresses which command the different bends of the channel up to Nagara.

The Brighton Electric Railway.—Last week the Lord Mayor of London (Sir Reginald Hanson), Mr. J. H. Puleston, M.P. for Devonport, and others paid a visit to Mr. Volk's Electric Railway at Brighton, which has just undergone repairs after the damage it sustained from a recent storm. The party took a double journey on the car and appeared to be extremely pleased with the excellence of the arrangements. Not long since the late Governor-General of New South Wales (Lord Augustus Loftus) made a minute inspection of the undertaking with the view of introducing an electric railway into Australia.

Charitable Telegraphists.—The ladies of the telegraph office at Manchester have organised and successfully carried out a sale of work in aid of the fund for extending St. Mary's Hospital, Manchester. The sale and accompanying entertainments resulted in a profit of £400.

Recent Awards.—The gold medal of the Liverpool Exhibition has been awarded to Messrs. Marshall, Sons & Co., who supplied the whole of the electric light machinery for the exhibition. Amongst other awards to this firm have been the gold medal of the Edinburgh International Exhibition; grand diploma of honour, Szt-Miklos, Hungary; the diploma of honour, Czernowitz, Austria; first prize, Gorinchen, Holland.

Personal.—Dr. R. Mullineux Walmsley, Senior Demonstrator at the Finsbury Technical College in the department of Applied Physics and Electrical Engineering, has been appointed Principal of the Sind State-aided Technical College which is now being established at Kurrachee.

The Julien Motor and Storage Battery.—Two trials of the Julien car were made in New York a week or so ago on the line of the Eighth Avenue Surface Railway. The car ran off the track once, which was attributed to the fact that the wheels did not fit the rails. It is designed to run the car at the usual speed run by street cars, though its maximum speed is said to be much greater. The car is lighted by electric lamps, and is easily controlled. The superintendent of the line was well pleased with the result of the tests. Mr. Julien, of Belgium, the inventor and electrician, was present when the trials were made.

Lecture on Electricity.—Prof. Oliver Lodge, D.Sc., lectured upon "Modern Views of Electricity" at the Birmingham and Midland Institute on Monday evening. The lecturer referred with satisfaction to the progress made in the solution of the problem of the nature of electricity and advanced reasons in favour of its materiality.

An Electric Submarine Boat.—The *Army and Navy Gazette* says:—"A formidable-looking monster, in the shape of a submarine torpedo boat on an entirely novel principle, was tried in the West India Docks last Monday. The boat is cigar shaped, built of steel, three-eighths of an inch thick, 60 feet long, with 8 feet beam. She is driven by electricity developing 45 horse-power, and is to be provided with an exit chamber similar to Jules Verne's in his book "Twenty Thousand Leagues Under the Sea"; so that she should be valuable for mining and counter-mining, besides carrying torpedoes. The principle on which she acts we are not at liberty to divulge at present, and it is perfectly impossible for any outsider to make out why she rises and falls at will when she is in the water, for only about 10 inches of her upper deck can be seen. We can only say that she does not sink by means of taking in water or by screws requiring a full head of steam to work them, for she can be lying peacefully on top when, by merely turning a wheel inside, she will disappear almost instantaneously on an even keel. The three gentlemen interested in her, with three engineers, went down in her to the bottom of the docks, about 17 feet, and rose and fell at pleasure. Once they stayed down about three-quarters of an hour, and tried a number of experiments, all of which were very satisfactory, and they discovered that they had a far greater reserve of rising power than they imagined. The invention seems a valuable one, as it can be adapted to larger vessels. The Government should look seriously into it, and try to prevent other Powers deriving benefit from it. A more extensive trial is coming off next week." This sounds almost too good to be true.

Run to Earth.—The story of the man who had been taking iron tonic and the deranged compass brings up to a writer in the New York *Electrical Review* an incident in hunting faulty insulation on an electric light line. The wire which was being tested was known to be clear, but the best test it would show was 600,000 ohms. It was discovered that a lineman was holding up the wire with a very dirty pair of hands. When he let go the insulation passed the required limit. "No wonder," said the foreman, "if Jim's feet are no cleaner than his hands, he'd ground two lines, easy."

The Charge of Tampering with Telegrams.—Meyer Henry Myers, who was recently charged with inciting a clerk in the service of the Exchange Telegraph Company to tamper with telegrams relating to sporting news, died suddenly last Saturday. He was to have appeared at the Middlesex Sessions on Tuesday to take his trial, but Mr. Kisch informed the Court of his death, and the indictment was withdrawn.

Electric Lighting in France.—Part of the well-known Bon Marché of Paris, *Industries* states, has just been furnished with the electric light. The 150 H.P. driving engine, which is of the Corliss type, has been made by Messrs. Garnier and Lecouteux. Three other similar engines will be supplied later on, giving a total of 600 H.P. for the complete installation. Cance and Jablochkoff arc lights are employed.—There is some talk of founding, in Paris, a new electric light company, with a capital of £400,000, under the auspices of the gas company, for France and abroad. The Edison Company at Ivry has constructed a 16 B 1,000 lamp dynamo for the Opera. The armature is 32 inches long by 24 inches diam. At a speed of 350 revolutions, the E.M.F. is 125 volts, the maximum current being 1,000 ampères. The magnets are shunt wound, requiring about 25 amperes when the magnetic field attains its maximum value of 5,000 C.G.S. units.

Gas v. Electricity.—The long pending lawsuit of the Milan Gas Company against the Municipality has, *Industries* announces, at last been decided in favour of the latter by the Commercial Tribunal of Milan. The verdict is as follows:—First, the defendants have not violated, by their introduction of the electric light, the Article V. of their convention with the gas company; secondly, the verdict is, therefore, in favour of the defendants; thirdly, the Municipality of Milan is absolved from paying any indemnity for losses accrued to the gas company by the introduction of the electric light in certain theatres, streets, and public places; fourthly, the gas company are allowed to appeal to a higher court, if they think fit, on the ground that part of the street lighting since July, 1885, has been taken from them, and also on the ground that, through the introduction of the electric light, they have been forced to reduce the price of their gas, and, consequently, the guaranteed income of 60,000 fr. from public lighting has been diminished. Each party paid their own costs in this action.

Electricity on Russian Farms.—Electricity has been brought into play in Russia in a peculiar manner, according to a writer in the *Journal d'Agriculture Pratique.* Owing to the severe competition of America and India in respect to wheat, Russian farmers and proprietors have lately sustained very heavy losses, which threaten to increase to an extent which will mean ruin to them. Realising this grave and very real danger, the editor of the Russian *Selsky Khosiane* has been making experiments with the electric light. One great, if not the greatest, disadvantage the Russian farmers experience is the shortness of the daylight, in consequence of which they cannot get sufficient wheat thrashed. To remedy this, the gentleman named has recently introduced on his farm the electric light, by which the work has been carried on later than was previously possible, and very satisfactory results have ensued.

A Strange Story.—The following very curious yarn was lately communicated to us, and though too late in the day for any action to be taken in the matter, and while in no way guaranteeing its accuracy, we consider it worth publication as a matter of interest to those engaged in cable work. Our informant related that some months ago a respectable looking man applied for a reward (being under the impression that such had been or would be offered) for the following information which had come into his possession, and which had been sworn to as the truth by one of the chief actors in the affair, namely, the mate. During a voyage from Dundee to Pensacola a barque (the name of which has been supplied to us) sighted on the evening of the 9th December, 1884, in the Bay of Biscay, some curious looking lights. Not being able to make out what they were attached to, a boat was sent away under charge of the mate to find out. He reported two lights on a telegraph buoy. The captain then ordered him to return to the buoy, cut the lamps adrift and bring them on board. A steamer, presumably a telegraph ship, was seen cruising in the neighbourhood, at some little distance from the buoy. The lamps in question were seen in Pensacola by the man who sought the reward, and his attention being called to them by their peculiar construction, he made enquires which resulted in the above history being communicated to him. It would be interesting to know if any cable work was being executed in the Bay of Biscay at the time mentioned, and if any lamps had been lost from a buoy. An outrage of this nature should be very severely punished. It is, unfortunately, not at all a rare occurrence that rope, chain, and even small buoys, are cut adrift and stolen by fishermen, but one would hardly believe that the captain of a large vessel would descend to such petty pilfering, considering that he would risk so much against so small a gain. Our informant added that there seemed to be no doubt as to the *bona fides* of the man who enquired as to a reward, and he seemed very much disappointed that his information should be valueless.

A Chemical Nuisance.—At the Guildhall this week, Leon Napoleon Loeb, of St. Michael's House, Church Alley, Basinghall Street, was summoned by Mr. Job Payne, a sanitary inspector of the city, for allowing a nuisance caused by a noxious smell on his premises. The defendant did not appear, but was represented by Mr. Cohen, his father-in-law. Dr. W. Sedgwick Saunders, medical officer for the city, said complaints having been made of a bad smell, he made several visits to St. Michael's House, the last time being on Monday last. There was a distinct taste of some metallic fumes, very offensive. Witness had made experiments, and used chemical test papers. His impression was that the fumes consisted of nitrous acid, which is a suffocating and poisonous gas. He gave the certificate produced. It was a nuisance, and injurious to health. It would be a nuisance to passers-by, though not injurious. The Alderman imposed a fine of £5 and the cost of the summons. Is not this a matter affecting the users of primary batteries?

Gas Explosion.—A severe explosion of gas took place on Monday at 20, Phillimore Gardens, by which Mr. G. Arthur Gildea, only son of Colonel Gildea, was badly burnt in the face and hands.

The Management of Accumulators.—We have received from Sir David Salomons, a pamphlet compiled by him, "On the management of accumulators." The comments contained therein, coming as they do from one whose experience of secondary batteries in a private capacity is probably unequalled, are necessarily valuable, and in our next issue we hope to deal somewhat fully with Sir David's notes.

The Society of Arts.—Mr. Reckenzaun is announced to read a paper after Christmas before the Society of Arts, the subject being that of electric locomotion.

An Electric Tramway for Margate.—Notices have been posted in Margate intimating that on or before December 23rd, application will be made to the Board of Trade for a provisional order to authorise the laying down of a tramway, plans of which will be deposited at the Town Clerk's office and other places by the end of the month. The project is for an electric tramway from the foot of the jetty to Westbrook, and extensions will be made from thence to Westgate on the west, and from the Jetty to New Town on the east. When the line is complete, a most appreciable boon will be conferred upon both Margate and the rising watering place, Westgate, as the two towns will be in direct and easy communication. Each section of the line will, as far as practicable, be laid with double lines of rails of narrow gauge (3 feet 6 inches), and the cars will be driven by means of accumulators. Each car will be constructed to carry from 30 to 40 passengers, and open cars will be available for fine weather. As the Royal assent cannot be given until August next, the line will not be constructed before that date, but the sections will be ready for work by the commencement of the the following season. Messrs. Thomson and Ritchie, of London, are moving in the matter, and have secured the consent of the Town Council.

The Electric Light and Photographic Transparencies.—At the recent Exhibition of the Photographic Society of Great Britain, Mr. Sebastian Davis, in introducing a show of photographic transparencies, took occasion to make some preliminary remarks upon the adaptation of the electric light for use in the lantern. He said that the Society had long felt that if a convenient form of electric lamp could be affixed to the lantern, of a portable kind, capable of being readily connected to its source of supply, and the latter could be kept constant with ordinary skill, it would be far more preferable for lantern exhibits than oxyhydrogen light. By the introduction of an electric lamp an element of danger would be avoided. The electric light, it was believed, also possessed the advantage of bringing out the half-tones of pictures much more clearly and softly than the oxyhydrogen light. A recent trial of an electric lamp had convinced the Society that their impression was correct.

Electric Lighting in Austria.—The capital of Styria (Graz) will receive an electric installation for street lighting, *Industries* states, the necessary power being obtained from the swift River Mur. Messrs. Chaudoir and Co. have bought the Austrian patents for the Berthoud Borel lead cables, and are now erecting works on the Western Railway for the manufacture of these cables. A department for the manufacture of accumulators will be annexed.

An Electrical Society.—It is proposed to establish a society of electrical engineers in Italy, on similar lines to the International Society of Electricians in Paris. The society will hold its meetings every month, and a general meeting annually.

NEW COMPANIES REGISTERED.

Telegraph Manufacturing Company, Limited.—Capital £25,000 in £10 shares. Object: To carry on business as telegraph engineers and contractors, and of manufacturers and dealers in dynamos, lamps, wire cables, accumulators, telephones and other electrical apparatus. Signatories (with one share each): *J. Taylor, Helsby; *G. Crosland Taylor, Chester; *F. Whiteley, Helsby; *J. S. Lewis (telegraph engineer), Helsby; Mrs. M. A. Taylor, Helsby; Mrs. M. Lewis, all in the county of Cheshire. Directing qualification, 50 shares. The signatories denoted by an asterisk are first directors. Registered 20th inst., by Messrs. Nelson Bros., 8, Brownlow Street, Holborn. Registered office, Britannia Telegraph Works, Helsby, Cheshire.

T. J. Howell, Limited.—Capital £1,000 in £1 shares. Objects: To carry on business as cutters, manufacturers and producers of carbons for plates, candles and other purposes, and as manufacturers of compressed and consolidated carbons and of all kinds of electrical apparatus. Signatories (with one share each): J. T. Hepburn, 7, Pancras Lane; F. J. Hentsch, Upper Halliford, Middlesex; B. H. Van Tromp, 16, Essex Street; W. J. Tippetts and W. A. Belcher, 11, Maiden Lane; F. J. Chambers, 1, Queen Street Place, E.C. Registered without articles of association on the 18th inst., by Messrs. Tippetts and Son, 11, Maiden Lane, Queen Street, E.C.

Pacific Telegraph Company, Limited. — Capital £2,000,000 in £10 shares. Objects: To establish, maintain and work telegraphic, telephonic and other communication between Australia, New Zealand and other islands or places in Australia, the Pacific Ocean, Africa, America, Europe or any of them. Signatories (with one share each): The Earl of Milltown, 2, Buckingham Gate; Sir James Corry, Bart., M.P., Dunraven, Belfast; Sir Daniel Cooper, Bart., 6, De Vere Gardens; Viscount Folkestone, 8, Ennismore Gardens; H. G. Reid, J P., Warley Hall, near Brigham; Sir Alfred Slade, Bart., Somerset House; J. Henniker Heaton, M.P., 36, Eaton Square. The signatories are to appoint the first directors and act *ad interim*. Registered 23rd inst., by W. Woodman, 115, Finborough Road, South Kensington.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

South Staffordshire Electric Lighting Company, Limited.—The annual return of this company, made up to the 18th inst., was filed on the 19th. The nominal capital is £100,000 in £5 shares. 139 shares have been taken up and £5 per share has been called thereon. The calls paid amount to £690 and unpaid to £5.

LEGAL.

Cocks v. The Great Western Railway Company.—This was an appeal before Lords Justices Cotton and Fry from an order of Mr. Justice North, directing the plaintiff's motion for a sequestration against the defendant company for breach of an injunction granted on July 26th last to stand over until the first motion day in the next sittings, upon undertakings given by the defendant company. The case arose out of the works recently erected by the Great Western Railway Company at the upper end of Gloucester Crescent, Paddington, for the purpose of supplying electric light to the hotel, station, and works at the Paddington terminus. Lord Justice Cotton, in giving judgment, said the first question was, whether the judge had a discretion to postpone his decision on a motion of sequestration. He (Lord Justice Cotton) considered that he had. Then, had he properly exercised that discretion? This raised the question whether there was a reasonable prospect on the evidence that, before the time to which the motion was postponed, the cause of the annoyance and the breaches of the covenant in the lease would be remedied. He thought there was such a reasonable prospect in this case. If there was a wilful disobedience of an injunction, that injunction would be sternly enforced. But in this instance the suspension of the operation of the injunction, issued in July until October 19th, was not in order that the company might stop the electric light and substitute gas, but that they might, by altering the machinery to the best of their skill, prevent their works causing any annoyance. The company must distinctly understand that if the nuisance was not remedied by January 11th, the injunction would be enforced. The evidence, however, showed that the company had done their best to stop the smoke nuisance with every prospect of success. As to the humming, steps were taken before this motion was made to stop the noise; they failed because, although the noise was stopped, so much heat was created as to be dangerous. The evidence of Sir F. Bramwell convinced him (Lord Justice Cotton) that there was a reasonable probability that this nuisance also would be removed before the date to which the motion was postponed. The experiments made by competent persons led him to conclude that there was no vibration caused by working the dynamos, and he anticipated that what the company were doing would remove that which gave the plaintiffs the impression that there was vibration. In his opinion, therefore, Mr. Justice North was right. The company had been doing their best to remove the nuisance complained of. If their efforts were effectual, there would be compliance with the injunction; if, however, they could not comply with the injunction without the removal of the electric light machinery, which they had put up, in disregard of the covenant in the lease, then that machinery would have to be removed. Lord Justice Fry concurred. The appeal was therefore dismissed.

Bannatyne v. The Direct Spanish Telegraph Company.—Before Lords Justices Cotton and Fry. This case raised rather an important question of company law, viz., whether a company which has under its articles issued preference shares with a fixed preferential dividend, can afterwards, without the consent of the holders of those shares, pass a resolution for the reduction of the whole of the capital, including the preference share capital, and consequently reduce the amount of dividend paid on the shares. On September 21st the directors called a meeting to consider the question of a proposed reduction of capital by writing off £5 per share on all the shares—in other words, to reduce the capital by one half. This resolution was confirmed at another meeting, when the plaintiff brought this action, and moved for an injunction to restrain the defendants from acting on the resolution. On October 29th last, Vice-Chancellor Bacon granted the injunction, and the company appealed. Their lordships now held that the company had power to reduce the capital, including the capital raised by the preference shares, unless there was a bargain with the preference shareholders to the contrary, and that in this case there was no such bargain. They therefore allowed the appeal.

Callow v. Young. — Before Mr. Justice Chitty. In this case a motion was made in December to restrain the defendant from carrying on the business of a telephone, telegraph, or bell-case manufacturer in the name of Frederick Young and Co. within 100 miles of the Royal Exchange. The defendant, who had been carrying on such a business at Lloyd's Row, Clerkenwell, gave an undertaking not to continue the business in that name. When the case came on for hearing on the 4th inst., the defendant did not appear, and judgment was given accordingly for the plaintiff. It was now proved that since the undertaking the defendant had continued to carry on the business. Application was therefore made for his committal, and the judge made an order of attachment.

Re A. F. St. George.—This was a meeting in the Court of Bankruptcy for public examination. The receiving order was made upon the petition of the United Telephone Company, Limited, Oxford Court, Cannon Street, the debtor being described as of 85, Chancery Lane, and Redhill, electrician. No accounts were filed, but the debtor, in his preliminary examination, estimated his liabilities at about £8,000, with assets of doubtful value, consisting chiefly of patent rights. The debtor now failed to appear, and Mr. Registrar Finlay Knight ordered an adjournment *sine die*.

CITY NOTES.

Blackpool Electric Tramway Company, Limited.

THE directors' report for the year ending October 31st, states that the revenue account shows the sum of £5,125 17s. 3d. as receipts, and £3,334 14s. 7d. as working expenses, or a balance of profit for the year of £1,791 2s. 8d. Adding to this £62 7s. 6d. from last year in respect of the period from the opening (September 12th) to October 31st, 1885, makes an available amount of £1,853 10s. 2d., of which the directors recommend the following appropriation:—A dividend of 5 per cent. on £20,025 (the called up capital of the company), £1,001 5s. 0d.; depreciation and reserve fund, £800 0s. 0d.; balance to next year, £52 5s. 2d. Total, £1,853 10s. 2d.

Eastern and South African Telegraph Company, Limited.—The numbers are published of 244 debentures of £100 each, amounting to £24,400, which have been drawn for payment at par on January 1st, 1887, at the banking house of Messrs. Barclay, Bevan & Co., 54, Lombard Street, E.C.

TRAFFIC RECEIPTS.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th November are £2,118, as compared with £1,830 in the corresponding period of 1885. The July receipts, estimated at £5,057, realised £5,154.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending November 19th were £4,290 after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending November 19th amounted to £5,246.

NEW PATENTS—1886.

14496. "Automatic electric current, governors or regulators." H. J. Haddan. (Communicated by C. F. Brush.) Dated November 18. (*Complete.*)

14974. "Electric safety lamps for use in mines, &c." M. Settle. Dated November 18.

14983. "Electrically actuated mechanical devices." E. W. Serrell. Dated November 18. (*Complete.*)

15030. "Dynamo-electric machines or slotted armatures." G. Hookham. Dated November 19.

15031. "Commutators for dynamo-electric machines." G. Hookham. Dated November 19.

15053. "Electric arc lamps." A. J. Beaumont. Dated November 19. (*Complete.*)

15075. "Combined portable or traction engines and dynamo-electrical machines." T. L. Aveling. Dated November 19.

15077. "Electric arc lamps." F. C. Phillips, H. E. Harrison. Dated November 19.

15078. "Automatic electric liquid level indicators." J. J. Ghegan. Dated November 20. (*Complete.*)

15094. "Holders or supports for incandescent electric lamps." J. H. Holmes. Dated November 20.

15123. "Incandescent lamps for use in mines or other places." G. C. Sillar, L. S. Powell. Dated November 20.

15156. "Arrangement of electrical conductors and contacts for telpher lines." C. S. E. Crakanthorp, A. W. Brewtnall. Dated November 22.

15160. "Electric meters." A. G. Brookes. (Communicated by K. Leitner.) Dated November 22.

15165. "Making incandescent electric lamps." W. Maxwell. Dated November 22.

15193. "Magnetic sock or sole lining." L. H. Hart. Dated November 22."

15198. "Electrical connections with moving bodies." T. A. Garrett. Dated November 22.

15202. "Smelting or reducing ores, &c., by electricity; apparatus therefor." L. Grabau. Dated November 22.

15209. "Electro-deposition of metals." T. Fenwick. Dated November 22.

15230. "Field magnets." L. Hanson. Dated November 23.

15271. "Regulating the flow of electric currents." H. H. Lake. (Communicated by E. Thomson.) Dated November 23. (*Complete.*)

15315. "Medical electrical machine." F. Bosshardt. (Communicated by L. Revol.) Dated November 24.

15325. "Electric shadeholder with single balance weight." J. Taylor, G. E. Tucker. Dated November 24.

15334. "Switches for operating electrical and other shunts." C. Browett. Dated November 24. (*Complete.*)

15344. "Automatic switch and governor for electric lighting appliances." A. M. Clark. (Communicated by Electrotechnische Fabrik Cannstatt.) Dated November 24.

ABSTRACTS
OF PUBLISHED SPECIFICATIONS, 1885.

13343. "Improvements in constant current dynamo-electric machines." S. P. Thompson. Dated November 4. 8d. Claims: 1. In a dynamo-electric machine in which the armature consists of coils of conductors wound in radial or peripheral hollows or pockets between teeth or projections at the flanks or circumference, the improved field magnet, substantially as described with reference to the drawings. 2. The construction of the cores of field magnets for dynamo-electric machines, of bars with cavities or pockets in their ends or sides, within which armature of the class named rotates, substantially as described and illustrated by the several examples shown, whether the cavities or pockets be cut out of or formed in a single bar, or be made by building up a number of bars, substantially as described. 3. In a dynamo-electric machine for supplying a constant or approximately constant current, the winding of the field magnets by placing the shunt coils nearest to the polar portions, and the series coils behind them as explained. 4. The construction of the armature of a dynamo-electric machine in groups of three coils, each group forming in itself a separate closed circuit, substantially as described.

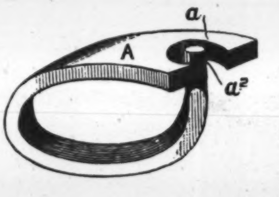
13485. "Improvements in the manufacture of incandescent lamps." W. Maxwell and T. V. Hughes. Dated November 7. 4d. Claim:—In the manufacture of incandescent lamps, enclosing them during exhaustion within a case or envelope through which or through the hollow walls of which air, gas or vapour heated to a suitable temperature is caused to circulate, substantially as and for the purposes herein set forth.

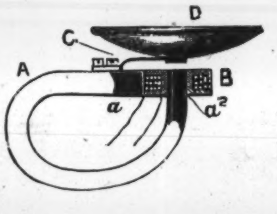
13639. "Improvements in the manufacture of carbon filaments for incandescent lamps." W. Maxwell. Dated November 10. 6d. Claim:—In the manufacture of carbon filaments for incandescent lamps, effecting their carbonisation by placing them in or on a mould or case which is electrically heated within a closed chamber containing a suitable atmosphere, substantially as described.

13721. "An automatic signalling electrical press button." F. T. Haig, G. B. Howard, B. F. Howard, and T. L. Haig. Dated November 11. 8d. Claim:—A method of making a numerical signal by a single push, or other action of the hand, by means of electrical action controlled by the slow ingress or egress of a fluid into or from a bellows or cylinder.

13810. "Improvements in electric lamps." V. Klan and F. Spurny. Dated November 12. 8d. Claims:—1. In an electric lamp, the combination with two carbon holders, of two pulley systems, one system having the pulleys mounted on fixed pivots, and the other system having a movable pulley or pulleys, and of independent cords passed over the pulleys of each system, both ends of both cords being connected with the carbon holders, substantially as described and shown on the drawings. 2. In an electric lamp, the combination, with two carbon holders, of two independent systems of pulleys, and cords passed over each system of pulleys, both ends and both cords being connected with the carbon holders, substantially as described and shown on the drawings. 3. In an electric lamp, the combination with two carbon holders, of solenoids in which they can slide, two systems of pulleys and independent cords passed over the pulleys of the two systems, both ends of both cords being connected with the carbon holders, substantially as described and shown on the drawings. 4. In an electric lamp, the combination with a carbon holder, of a tube in which the same can slide, such tube being mounted to slide in a solenoid, substantially as described and shown on the drawings. 5. An electric lamp provided with telescopic carbon holders, substantially as described and shown on the drawings. 6. In an electric lamp, the combination with a tube having an internal collar at one of its ends: of the sliding carbon holder, provided with the head or piston at one end, substantially as described and shown on the drawings.

13828. "Improvements in magneto-telephonic instruments." S. P. Thompson and P. Jolin. Dated November 12. 8d. Fig. 1 represents a long, narrow, triangular or tapering strip of steel, A, having a circular hole or slot cut out of its broader end at *a*. The said strip is bent as represented, so that the narrow or small end, a^2, passes up into the said hole or slot, *a*. The curved strip is then magnetised so that the end, a^2, constitutes one pole, and the hedges of the slot or hole, *a*, the other pole of the magnet. In the annular space between the poles the coil, B, is placed as shown in fig. 2, its ends being secured to suitable terminals, one or both of which is or are screwed or otherwise fixed or fitted into an insulating block, or into insulating blocks, fixed to the instrument at any convenient part thereof. A light but strong spring, preferably of steel or other magnetic material, C, is fastened to the part, A, so that one of its ends, or part of it, passes over the central pole, a^2, in the part, A, and the said spring may be prevented from being brought into actual contact with the pole by the interposition at some point of a cushion of cork or India-rubber, or of a brass pin or its equivalent. To the said spring, C, at or near that part of it which is immediately above the pole, a^2, is rivetted or otherwise secured, a dish or cup, D, of metal, ebonite, celluloid, or other similar hard material of a convenient size, to fit to or place over the ear, and it is not fixed at any other part than at or near its central part where it is attached or rivetted, preferably by an iron rivet to the spring, C. The spring, C, may be attached to the part, A, at one end, or at both ends, or it may be triangular, and be attached at points along one side. Claims:—1. A telephonic instrument consisting of a magnetised part, A, formed as described, and provided with a coil, and with a dish or cup, or the like, mounted upon a spring or equivalent yielding part, substantially as described and illustrated. 2. In a telephonic instrument, the employment of a cup or dish, attached at its centre to a spring or other equivalent yielding support, and not attached at any other part, and arranged so as to be capable of receiving from a neighbouring coil or coils, and transmitting magneto-electric impulses.





13873. "An improved apparatus for regulating and controlling electric currents." A. Grundy. Dated November 13. 8d. A series of permanent or electro-magnets being acted upon partly by the main current and partly by a shunt current from either the genarator or accumulator or from both shall according to the preponderance or variation of potential or current from either the generator, accumulator, or other part of the circuit make or break the connection between them. The claims are three in number.

14213. "Improvements in insulated electric conductors." A. MILLAR. Dated November 20. 4d. Claim :—The method of forming insulated conductors by combining together two or more ribands of metal, and surrounding or enveloping the combined series of ribands with a covering of insulating materials, substantially as described.

14214. "Improvements in insulated electric conductors." A. MILLAR. Dated November 20. 4d. Claim :—The method of protecting the insulated covering of electric conductors, by forma sheath or covering of flat-wire wound up the outside of the insulated conductor, substantially as described.

CORRESPONDENCE.

The Law of Winding for Self-Regulating Motors.

In the article on electric motors in America, on p. 487, the writer—an anonymous one—gives the following as the "Sprague law" of winding motors to be self-regulating. "The number of turns in the shunt coil must bear the same ratio to the number in the series coil as the resistance of the shunt coil bears to the sum of the resistance of the series coil and the armature." I am also informed that Mr. F. J. Sprague has lately patented this "law." Will you permit me to point out that this identical "law" was published in the summer of 1884 in the first edition of my work on "Dynamo-Electric Machinery," p. 367, equation No. LIV. (or p. 451 of the second edition), where it is given as a mere development of the well-known theory of self-regulating motors of Profs. Ayrton and Perry, published in May, 1883. If the law is anybody's, it is Profs. Ayrton and Perry's, not Mr. Sprague's law.

Silvanus P. Thompson.

November 19th, 1886.

Welding by Electricity.

I observe that one of the three-cornered duels on priority to which the electrical public is treated regularly every few months has broken out on the subject of welding by electricity. It appears that this "invention" is claimed by Prof. Elihu Thomson, and by Mr. J. B. Duncan; also under the gorgeous name of the "electrohephaest" process (wasn't Hephaestus the same as Vulcan of old ?) by Messieurs Nicolas de Benardos and Stanislas Olszewski. The latter gentlemen having lately been under the wing of M. Marcel Deprez the "inventor" of "motive force capable of electric transport," that circumstance may perhaps account for their magniloquent new name for an old process. But why do not the rival claimants to the invention of *electrohephaest* consult the works of Mr. J. P. Joule, who invented welding by electricity when they were wearing bibs ?

Y. O. Y.

Secondary Generators.

During the year 1882, being then in Boston, Mass., I carried out a series of experiments upon the use of the induction coil for the purpose of supplying electrical energy from central stations. As a result of these experiments I made an application to the United States Patent Office. The application was filed on January 29th, 1883, and contained a complete description of a system, in which alternating or undulating currents of high tension generated in a central station, are used in combination with induction coils, which transformed the electric energy, conveyed by the mains, into a number of currents of low tension and large quantity. Various arrangements were described and shown in the drawings.

The substance of this rather lengthy application may best be seen from one of its claims, which reads literally as follows :—

"The combination in a system of electrical distribution of a generator adapted to produce electric currents of high E.M.F., a continuous conductor, including the primaries of a series of inductoriums and forming an internal circuit for the said generator ; and a series of secondary circuits, each including one or more electric lamps, and formed of the secondary circuits of the said inductoriums, whereby the high tension currents, flowing in the main conductors and primaries, are enabled to develop secondary currents of low tension and great volume in the secondary circuits, substantially as and for the purpose described."

The application was rejected, and the objection of the Patent Office commenced as follows :—"Applicant should demonstrate more clearly to the office, the possibility of producing quantity currents from intensity currents by means of an induction coil ; it is not apparent how applicant in any case can get more quantity from a secondary coil than he has in his primary."

I now find that a patent has been granted to Messrs. Gaulard & Gibbs on October 26th, 1886, of which the first claim reads as follows :—"(1.) The hereinbefore described art or method of electrical distribution and conversion, which consists in establishing in a closed electric circuit, a current of alternate and equal positive and negative potential, producing by the influence of such current an inductive field of alternate polarity, and thereby inducing in translating devices situated in an independent closed circuit traversing such field, a similar alternating current of greater quantity and less potential than the originating or producing current."

I do not see any material difference between the claim which was refused to me in 1883, and that which is granted to Messrs. Gaulard & Gibbs in 1886. It is quite apparent that the examiner in 1886 had a clearer view of the function of an induction coil than was the case in 1883.

I may also mention that in my experiments at that time I made use of a continuous iron core for the induction coil.

Although I am quite willing to acknowledge the merit of those who have in the meantime brought this system into practical application, I do suppose that I am entitled to all those rights which are due to me on account of priority of invention.

Alexander Bernstein.

Testing Dynamos.

I think Captain Cardew does me some injustice in interpreting me to say he is not capable of realising the perfection of his own system. In my article in the *Electrician* I say nothing nearly so wild; but that at the date of the publication of the tests of the Edison-Hopkinson machines "Captain Cardew does not seem to have realised that his system was capable of such great perfection, and appears to have merely measured the loss of power electrically, and to have split it between the two machines." This is as described by Captain Cardew in the ELECTRICAL REVIEW of March 12th, 1886.

Of course, I am as well aware as other people that he can develop his system ; but I was writing history, and Captain Cardew's method, as described by him on the 12th of March, 1886, was not the realisation of the great perfection of which his system is capable.

As to the necessity for three large machines. To test a 50 H.P. dynamo by Captain Cardew's method a 50 H.P. motor is needed, and a third still larger machine to feed the system. In other systems described the 50 H.P. dynamo can be tested with a 50 H.P. motor and an auxiliary 10 H.P. dynamo, or even with a 5 H.P. dynamo alone ; so that Captain Cardew's system, compared with others in the same article, takes three large dynamos, instead of two, or only one.

Jas. Swinburne.

[illegible] Company, Limited,
European Works, [illegible] Road, DALSTON,
NEAR [illegible] STATION.

[illegible]—Paris, 1881; Vienna, 1883; [illegible], 1884; [illegible] [illegible], 1885.

Dynamos.—[illegible] Dynamos for Incandescent and Arc Lighting, Ship Lighting, Mining, &c.

Search Lights for Naval and Military purposes; Submarine Arc Lamps for Salvage or Fishing.

Engines.—High Pressure and Condensing; Steam Boilers, Turbines, Water Wheels, Overshot [illegible], Shafting, Pulleys, Plummer Blocks, Gearing, Belting, &c.

Arc Lamps.—Licensees and Makers of Pilsen, Clark-Brennan, [illegible], "J. P.," and other Lamps.

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Voltmeters.	Ammeters.
Cardew,	Electro-magnet,
Electro-magnet,	Ayrton & Perry,
Ayrton & Perry.	Engine Room.

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THE LEA TELEGRAPH WORKS, HACKNEY WICK,
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[illegible] OF
MACINTOSH LANE, HOMERTON.

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DUBLIN	15, St. Andrew
BRISTOL	2, Clare Street.
NEWPORT, MON.	32, Dock Street.
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NEWCASTLE-ON-TYNE ...	6, Neville Street.
NORTH SHIELDS	Borough Road.
BIRMINGHAM	Cobden Buildings, Corporation Street.